MOBILE LEARNING ENVIRONMENT DESIGN REQUIREMENTS FOR QURAN READERS WITH DOWN SYNDROME

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KUALA LUMPUR
2018

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THESIS SUBMITTED IN FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

FACULTY OF COMPUTER SCIENCE & INFORMATION TECHNOLOGY UNIVERSITI MALAYA
KUALA LUMPUR

2018

UNIVERSITY OF MALAYA
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Matric No: **WHA120004**
Name of Degree: **DOCTOR OF PHILOSOPHY**
Title of Project Paper/Research Report/Dissertation/Thesis ("this Work"):
MOBILE LEARNING ENVIRONMENT DESIGN REQUIREMENTS FOR QURAN READERS WITH DOWN SYNDROME
Field of Study: **Human Computer Interaction (COMPUTER SCIENCE)**

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MOBILE LEARNING ENVIRONMENT DESIGN REQUIREMENTS FOR QURAN READERS WITH DOWN SYNDROME

ABSTRACT

Educational technology refers to the process of teaching or tools that help teachers make teaching and learning more effective. The advances of computer technology in the era of education is aimed to make sure that the information revolution will affect students' lives more deeply and thoroughly. Hence, it is very important to study and understand the real needs of users to enable these technology-based learning aids to achieve that goal. Besides that, people with special needs, especially learning disabilities, are in dire need of assistance in terms of science and technology in their daily lives. Therefore, in a learning environment, it is important to produce a learning app that fits the real needs of students in their learning environment. Based on the literature review, there is a lack of information on learning environments for people with learning disabilities, especially in Islamic studies. In Malaysia, the Down syndrome (DS) population is increasing and requires special attention, especially in their education later on. Furthermore, there is a lack of learning apps that suit the learning environment of DS students. Based on these problems, this study aims to i) identify factors associated with the learning process and the learning environment of children with DS; ii) obtain the appropriate method to recite the Quran (targeted to recognise ***hijaiyah*** letters) for children with DS; iii) propose a model to assist students with DS in the learning process that uses their learning strengths; and iv) evaluate the acceptance levels against the M-learning prototype app among the DS children in the process of recognising the ***hijaiyah*** letters. This research design was developed according to a method adapted from the User Centred Design process (UCD). The data collection in this study was conducted using the Fuzzy Delphi Method (FDM) that includes analysing relevant documentations, doing expert

interviews, observation and studies using questionnaires to acquire requirement needs and good factors in a learning environment for DS students. Meanwhile, the Human Computer Interaction (HCI) guidelines are used to understand the learning environment for children. Data collection was obtained from interview sessions with 12 teachers, observation sessions with 13 students with DS, and surveys with 30 participants; whereby the students' skill of learning is taken into consideration for the purposes of user requirement needs. The findings of this research have highlighted studies on the identification of characters of DS students, their environment of learning, and requirements of learning technology aids in terms of DS students' requirements in their learning environment. Through this study, characteristics of DS students and their requirement needs in the learning process can be understood more clearly. A Down Syndrome Enhanced Requirements Learning (DSERL) model was suggested to help the software developer or programmer to create an app or learning software that are most appropriate for DS students. This model is based on the environment of Mobile Learning (M-learning), the basic elements of M-Learning Characteristic Framework by Martin and Ertzberger (2013), and Learning environment and Learning Style of DS as the outcome of the data collection in this study. In addition, this study also contributed to the Muslim community by developing an app for "Jawi" alphabets recognised as a prototype for DSERL; whereby it can be seen as an alternative that provides equal opportunity for children with DS to recite the Quran just like normal children do.

Keywords: Educational technology, user requirement, learning disability, Down syndrome, Mobile Learning, User Centre Design process, Human Computer Interaction, Fuzzy Delphi Method.

KEPERLUAN REKABENTUK PERSEKITARAN PEMBELAJARAN MUDAH ALIH UNTUK PEMBACA QURAN DENGAN SINDROM DOWN

ABSTRAK

Teknologi pendidikan merujuk kepada proses pengajaran atau alat bantu belajar yang membantu guru membuat pengajaran dan pembelajaran dengan lebih berkesan. Kemajuan teknologi komputer dalam era pendidikan adalah bertujuan untuk memastikan bahawa revolusi maklumat akan memberi kesan kepada kehidupan pelajar lebih mendalam dan menyeluruh. Oleh itu, sangat penting untuk mengkaji dan memahami keperluan sebenar pengguna untuk membolehkan alat pembelajaran berasaskan teknologi dapat mencapai matlamat tersebut. Di samping itu, orang yang berkeperluan khas, terutamanya ketidakupayaan pembelajaran, sangat memerlukan bantuan dari segi sains dan teknologi dalam kehidupan seharian mereka. Oleh itu, dalam persekitaran pembelajaran, adalah penting untuk menghasilkan aplikasi pembelajaran yang sesuai dengan keperluan sebenar pelajar dalam persekitaran pembelajaran mereka. Berdasarkan kajian literatur, terdapat kekurangan maklumat mengenai persekitaran pembelajaran bagi orang yang kurang upaya pembelajaran, khususnya dalam pendidikan Islam. Di Malaysia, populasi sindrom Down (DS) semakin meningkat dan memerlukan perhatian khusus, terutamanya dalam pendidikan mereka masa akan datang. Selain itu, terdapat kekurangan aplikasi pembelajaran yang sesuai dengan persekitaran pembelajaran pelajar DS. Berdasarkan masalah ini, kajian ini bertujuan untuk: i) mengenal pasti faktor-faktor yang berkaitan dengan proses pembelajaran dan persekitaran pembelajaran kanak-kanak dengan DS; ii) mendapatkan kaedah yang sesuai untuk membaca Al-Quran (disasarkan untuk mengenali huruf hijaiyah) untuk kanak-kanak dengan DS; iii) mencadangkan model untuk membantu pelajar dengan DS dalam proses pembelajaran yang menggunakan kekuatan pembelajaran mereka; dan iv)

menilai tahap penerimaan terhadap aplikasi prototaip M-pembelajaran di kalangan kanak-kanak DS dalam proses mengenali huruf hijaiyah. Reka bentuk penyelidikan ini dibangunkan mengikut kaedah yang diadaptasi dari proses Reka Bentuk Pengguna Pusat (UCD). Pengumpulan data dalam kajian ini menggunakan kaedah Fuzzy Delphi (FDM) yang merangkumi menganalisis dokumentasi yang relevan, melakukan wawancara pakar, pemerhatian dan kajian menggunakan soal selidik untuk memperoleh keperluan keperluan dan faktor yang baik dalam persekitaran pembelajaran untuk pelajar DS. Sementara itu, garis panduan Interaksi Komputer (HCI) digunakan untuk memahami persekitaran pembelajaran untuk kanak-kanak. Pengumpulan data diperolehi daripada sesi wawancara dengan 12 guru, sesi pemerhatian dengan 13 pelajar dengan DS, dan tinjauan dengan 30 peserta; di mana kemahiran belajar pelajar dipertimbangkan untuk keperluan pengguna. Penemuan kajian ini telah menyerlahkan kajian mengenal pasti watak-watak pelajar DS, persekitaran pembelajaran mereka, dan keperluan pembelajaran teknologi pembelajaran dari segi keperluan pelajar DS dalam persekitaran pembelajaran mereka. Melalui kajian ini, ciri-ciri pelajar DS dan keperluan mereka dalam proses pembelajaran dapat difahami dengan lebih jelas. Model Down Syndrome Dipertingkatkan (DSERL) telah dicadangkan untuk membantu pembangun perisian atau pengaturcara untuk membuat perisian aplikasi atau pembelajaran yang paling sesuai untuk pelajar DS. Model ini berdasarkan persekitaran Pembelajaran Mudah Alih (M-learning), unsur-unsur asas Rangka Kerja Ciri M-Pembelajaran oleh Martin dan Ertzberger (2013), dan hasil pengumpulan data iaitu persekitaran pembelajaran pelajar DS dan gaya pembelajaran pelajar DS. Di samping itu, kajian ini turut menyumbang kepada masyarakat Islam dengan membangunkan aplikasi untuk huruf "Jawi" yang diiktiraf sebagai prototaip untuk DSERL; di mana ia dapat dilihat sebagai alternatif yang menyediakan peluang yang sama untuk kanak-kanak dengan DS untuk membaca dan mengenal Al-Quran seperti kanak-kanak normal .

Katakunci: Teknologi pendidikan, keperluan pengguna, kurang upaya pembelajaran, Sindrom Down, Pembelajaran Mudah Alih, Proses Rekabentuk Pusat Pengguna, Metodologi Fuzzy Delphi.

ACKNOWLEDGEMENTS

First and foremost, I would like to extend my sincere gratitude to my supervisor, Dr. Nazean Jomhari for her extensive knowledge and exceptional guidance for this research. Thanks for believing and pushing me to go and outdo myself. I would also like to thank the management of FAQEH for giving me the help and opportunity to conduct case studies in children with Down syndrome

To my husband, En. Azizi bin Mansoor, my utmost respect and appreciation for believing and undeterred confidence in me, that I will complete this research. I will always cherish your love and support. My two lovely daughters and my little baby, Nurin Imanie, Nur Iffah Imanie and Muhamad Dzulfiqar, your Umie had finally did it. Thanks for your patience and love that has got me this far. I am forever in debt with all of you.

These thanks go to all of the students and teachers in FAQEH UM, PSDM, KIWANIS Klang and Sek. Keb. MERU 2 that I went for survey and testing. Last but not least, this also goes to my beloved mother, Pn. Sadariah Osman and Pn. Halijah, and also my beloved sister and brother, Zuraidah, Rashidah, Khairul Anuar, Haji Yusri, Normaizura, Normadiah, Norazizi and Abdul Ayub for undying support and wisdom in keeping me going. My sincerest thanks. All the words in the world is not enough to thank you all. May Allah bless you all with His Rahman and Rahim.

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1. HCD – Human Capital Development
2. STI – Program in Science, Technology & Innovation
3. MOSTI – Ministry of Science, Technology and Innovation
4. PWDs – people with disabilities
5. CRC – Convention on the Rights of the Child
6. CRPD – Convention on the Rights of Persons with Disabilities
7. SWD – Social Welfare Department
8. MOH – Ministry of Health
9. MOE – Ministry of Education
10. MVC – Model-View-Controller
11. UNESCAP – United Nations Economic and Social Commission for Asia and the Pacific
12. UNICEF – The United Nations Children's Fund
13. IT – Information Technology
14. CET – Council for Educational Technology
15. ICT – Information And Communication Technologies
16. TEL – Technology-Enhanced Learning
17. M-Learning – Mobile learning
18. HCI – Human-Computer Interaction
19. DS – Down syndrome
20. LD – Learning Disabilities
21. UCD – User Centred Design
22. FDM – Fuzzy Delphi Method
23. MWFCD – Ministry of Women, Family and Community Development
24. APPGDS – All Party Parliamentary Group on Down Syndrome
25. DSAQ – Down Syndrome Association of Queensland

26. VARK – Visual, Auditory, Read/write, and Kinesthetic

27. E –Learning – Electronic Learning

28. EXE – An Executable File Format

29. TLT – Teaching and Learning Theory

30. SMK – Sekolah Menengah Kebangsaan

31. CADS – Children's All Day School

32. PSDM – Persatuan Down Syndrome Malaysia

33. KIWANIS – A Global Organization of Volunteers Dedicated to Improving the World One Child and One Community at a Time.

34. UML – The Unified Modeling Language

35. OS – Operating System

36. DVM – Dalvik Virtual Machine

37. XML – Extensible Markup Language

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CHAPTER 1 : INTRODUCTION

1.1 INTRODUCTION

In the context of a globalised world, the human capital of high integrity is desperately needed by the country. Starting with the Ninth Malaysia Plan, 2006, human capital development of high integrity is emphasised by the government of Malaysia because they want Malaysia to be a developed and competitive country as well as have a main knowledge-based economy. Human Capital Development (HCD) is the main thrust of the Malaysian plan in line with the national mission. The HCD Program in Science, Technology & Innovation (STI) is the government's effort and investment in increasing technical skills, creativity and innovation to drive a knowledge-based economy. The objectives of HCD are: (i) to increase the critical mass of researchers, scientist and engineers (RSE) in the country to achieve a ratio of 50 RSE: 10,000 labour force of priority areas by 2015; (ii) to increase the skills of conducting high quality and market driven research to meet global standards; and (iii) to increase competitiveness and R&D management skills. Therefore, human capital development of high integrity also involves people with disabilities (PWD), because they are also part of the workforce that contributes to the development of the country. A good education system that has the capability to transform students in order to meet future demand will produce highly-skilled human capital ("Malaysia Education for All", 2015).

The Malaysian government has started to work on people with disabilities in this country. Some actions have been taken by the government, including having ratified the Convention on the Rights of the Child (CRC) in 1995; enacted the PWD Act in 2008; and in 2010, the government ratified the Convention on the Rights of Persons with Disabilities (CRPD). In addition, the Social Welfare Department (SWD) under the

Ministry of Women, Family and Community Development, the Ministry of Health (MOH) and the Ministry of Education (MOE) have also been providing programs and services for the care, protection and development of children with disabilities. In 2012, Malaysia, together with members of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), set up the Incheon Strategy to "Make the Right Real" for people with disabilities in Asia and the Pacific. The Incheon Strategy comprises 10 goals, 27 targets and 62 indicators to improve the quality of life and fulfil the rights of the disabled, by strengthening the physical environment, public transport, knowledge, information and communication. One of the main principles and policy direction of the Incheon Strategy is to instil "respect for the evolving capacities of children with disabilities and respect for the rights of children with disabilities to preserve their identities" ("United Nations Children's Fund (UNICEF) report", 2014).

Malaysia's PWD Act states that people with disabilities "include those who have long-term physical, mental, intellectual or sensory disabilities which in interaction with various barriers may hinder their full and effective participation in society". Broad terms and the word 'include' in this definition suggests that the categorisation of persons with disabilities is open to interpretation. The Ministry of Women, Family and Community Development has, however, certain categories of disabilities for the purpose of registration of persons with disabilities. They state that learning or intellectual disabilities in Malaysia, is defined as "learning disabilities". Children with learning disabilities (LD), include those diagnosed with Down syndrome (DS), mild Autism, Attention Deficit Disorder, Mild Retardation and Specific Learning Disabilities (e.g. dyslexia).

By the end of 2012, the SWD national registration system had 445,006 registered disabled persons and they represented 1.5 percent of the country's population ("United Nations Children's Fund (UNICEF) report", 2014). Meanwhile, the MOH compiled some statistics on the number of children with disabilities, through registration data compiled from hospitals and health clinics. Table 1.1 below is a tabulation of the number of children with special needs that were identified and registered in the MOH database from 2004 to 2012. The term 'special needs' includes hearing problems, vision problems, physical disabilities, DS, autism, attention deficit hyperactivity disorder (ADHD), mental disability and other specific LD.

TABLE 6: 2012

Age Group (years)	HEARING IMPAIRMENT				VISUAL IMPAIRMENT		PHYSICAL DISABILITY	CEREBRAL PALSY			LATE DEVELOPMENT	DOWN SYNDROME	AUTISM	ADHD	MENTAL DISABILITY	SPECIFIC LEARNING DIFFICULTIES	SLOW LEARNER	OTHERS**	TOTAL
	MINIMAL	MODERATE	SEVERE	PROFOUND	BLIND	LIMITED VISION		HEMIPLEGIA	DIPLEGIA	QUADRIPLEGIA									
0 - < 1	-	2	1	1	4	8	57	18	7	19	96	274	-	-	-	-	-	135	622
1 – 2	-	6	7	-	4	10	37	25	10	24	169	102	14	7	-	12	8	62	497
3 – 4	1	4	14	2	3	1	20	24	5	14	93	26	54	14	2	14	13	49	353
5 – 6	1	2	6	-	5	5	11	11	7	2	21	24	58	28	6	59	38	37	321
7 – 12	5	6	6	-	3	4	31	9	13	14	16	26	33	43	59	251	205	47	771
13 – 18	-	3	2	-	7	1	10	5	2	6	5	18	11	4	20	50	44	14	202
TOTAL	7	23	36	3	26	29	166	92	44	79	400	470	170	96	87	386	308	344	2,766

Table 1.1: The number of children with special needs identified and registered in the MOH database from 2004 to 2012 (Child Protection Section of UNICEF Malaysia, 2013.)

The table above shows that the number of DS children registered is more than the other groups. These data indicate that the DS population is increasing and requires special attention, especially in their education later on. Many children will have special educational needs of some kind during their education. Schools and other organizations can help most children overcome the barriers that their difficulties present quickly and

easily. A few children will need extra help for some or all of their time in school. Therefore, special educational needs could mean that a child has:

- Learning difficulties – in acquiring basic skills in school;
- Emotional and behavioural difficulties – making friends or relating to adults or behaving properly in school;
- Specific learning difficulty – with reading, writing, number work or understanding information;
- Sensory or physical needs - such as hearing or visual impairment, which might affect them in school;
- Communication problems – in expressing themselves or understanding what others are saying; and
- Medical or health conditions – which may slow down a child's progress and/or involves treatment that affects his or her education.

Children make progress at different rates and have different ways in which they learn best. Teachers take account of this in the way they organise their lessons and teach. Children with slower progress or have certain difficulties in one area may be given extra help or different lessons to help them succeed. The use of information technology (IT) as a learning tool as seen nowadays is very encouraging. It is an alternative method that can help students with disabilities to be successful in their studies. Asia is also not an exception to this situation where a lot of apps or software for learning are available, especially on the Internet, that can help students with disabilities to learn better.

1.2 BACKGROUND

Educational technology or IT is a complex process and involves integrating people, procedures, ideas, equipment, and organisations; to analyse problems and design,

evaluate and manage the solutions for the problems that arise in situations where the learning process is aimed at. This means that educational technology refers to the process of teaching or tools which help teachers to achieve teaching and learning more effectively. Technology can be material objects such as machines or hardware, but it can also include a wider meaning, that includes systems, methods of preparation and technique. The rapid and lively development of globalisation is making the technology world very important in education. This is supported by the words of Hjetland (1995), that is "Technology can make our lives easier. Everyday tasks are simplified." Similarly, the views expressed by Winston Churchill in Vaithiyanathan (2012), said that "empires in the future are the empires of thought and intelligence mindset". To develop the thinking and mindset of the students, the teaching approach and learning technology in education should be composed of thinking research, collecting information, and analysing data towards encouraging creativity and motivation of the students. It is appropriate in today's world which is a world without borders. All information can simply be reached by your fingertips. Students need to explore the field of technology for the development of a country. Likewise, people with special needs are also in dire need of assistance in the field of science and technology in their daily lives. Many definitions are given to those with special needs in learning, but generally, learning disabilities are classified as neurological disabilities that affect the ability to understand, remember or to communicate.

Advances in computer technology and the new era of education in fact want to make sure that the information revolution will affect our lives more deeply and thoroughly. The Education Technology Council, United Kingdom, defines technology in education as a formation, implementation and evaluation of the systems and techniques that help to improve the learning process (Bell & Harris, 2013). The National Center for Learning

Disabilities, United Kingdom, also defines the application of technology in education as scientific knowledge about learning to improve the effectiveness and efficiency of teaching and training (Cowan, 2008). Meanwhile, the Learning Technology Commission, USA, defines technology in education as a systematic way to design, implement, and evaluate the whole process of teaching and learning in terms of specific objectives, based on research of human learning and communication, by using a combination of human and non-human resources that lead to effective teaching. Educational technology can correct any confusion or misinterpretation because it gives a comprehensive overview and a clear concept and its relevance to everyday life, whereby it involves multi-sensory learners, i.e. those relying on the use of visuals followed by audio to involve the senses of sight and hearing as well as a possible sense of touch. This will increase the involvement of sensory memory of students. It also provides differences and diversity of teaching methods to help students get the maximum learning effect with minimum use of time and enriches the students' learning experience using mobile media, as if they are experiencing it themselves.

Technology education is a teaching aid and cannot be used to replace teaching. It is used to help teachers teach a topic more effectively. The importance of the use of technology in education cannot be denied any longer. Undeniably, technology or teaching aid is absolutely needed to assist students in developing a stronger grasp of language (Arshad, 2003; Dowling, 1999). Technologies have a major impact on the process of learning, especially when teaching a lesson that requires the students to use their minds to the optimum level. Computers help teachers achieve the objectives of teaching and learning if used systematically. Teaching that is included with the latest teaching aids can increase students' interest in learning something in the educational field. In addition, if the computer can be used systematically and effectively by teachers, it is able to solve

any problems of teaching and learning. This is consistent with the view of Morrison, Ross, Kemp and Kalman (2010), which states that computers can enrich teaching techniques and also an information processing machine that must be instructed by the user. The study also states capable computers that control and manage a lot of teaching materials. Computer capabilities enable users to interact with instructors to make teaching and learning easier and interesting. Brodie (1992) stipulates that computers can work faster and operate continuously for 24 hours, and the information released is accurate. Computer use is entirely related to information technology and communications which are now applied in the education system. This is because the computer is used as the database, which can provide the information sought or requested by the public. In addition, the effects of the use of technology in education can make the learning process a more active and fun learning environment. With the advent of technology in education, teachers can diversify the teaching and learning process and not just focus on technique alone, but also improve the quality of teaching by using the facilities that are available in information and communications technology (ICT) or E-learning environment.

Furthermore, the researchers state that E-learning (or eLearning) is the use of electronic media as well as ICT in education. E-learning is broadly inclusive of all forms of educational technology in learning and teaching. E-learning is inclusive of, and is broadly synonymous with multimedia learning, technology-enhanced learning (TEL), computer-based instruction (CBI), computer-based training (CBT), computer-assisted instruction or computer-aided instruction (CAI), Internet-based training (IBT), web-based training (WBT), online education, virtual education, virtual learning environments (VLE) (which are also called learning platforms), Mobile learning (M-

learning), and digital educational collaboration (Garrison, Anderson, & Archer, 2001; Zhang, Zhao, Zhou, & Nunamaker Jr, 2004).

E-learning is often used as a unifying term to describe the fields of online learning, web-based training and technology-delivered instruction. M-learning or ubiquitous learning (U-Learning) are examples of E-learning. Whilst the term E-learning superseded terms such as educational technology, learning technology or ICT, it has been superseded itself by terms such as 'technology enhanced learning'. Some definitions focus on specific technologies or a range of technologies. For example, the UK government's Post-16 E-Learning Strategy Task Force defined e-learning as: 'The Internet, intranets, wireless networking, PC (personal computer) based technologies, handheld computers, interactive TV, and also e-technology to support traditional delivery, for example using electronic whiteboards and video ('Contextualising the Scene conferencing', DfES, 2002, p. 2). Kelly, Phipps and Swift (2004) also include the use of email and dedicated software to define the term E-learning. Other definitions emphasise print-based, graphical and audio-visual learning resources, including electronic information resources provided by libraries. The fact that E-learning can be employed in face-to-face campus settings or at a distance as learners connect from home, work or other public spaces such as libraries (Burgstahler, Corrigan, & McCarter, 2004) gives it a flexibility that is very attractive when thinking about the needs of disabled students who may not wish to be dependent on single location resources or single media. Therefore, for the purposes of this study, E-learning is understood as 'any technology that might support and enhance the learning'. These technologies might be networked, stand-alone or mobile.

TEL aims to design, develop and test sociotechnical innovations that will support and enhance learning practices of both individuals and organisations. It is, therefore, an application domain that generally covers technologies that support all forms of teaching and learning activities. Nowadays, the M-learning tools in learning sessions have become more popular and are very helpful to support learners in their learning. For a long time, human-computer interaction (HCI) involves research, planning and design interaction between people (users) and computers. Kaptelinin and Bannon (2012) have outlined a vision of interaction design as a new profession, which benefits all variety of disciplines, including HCI. The researcher explained that the increasing importance of designing spaces for human communication and interaction space (emphasis added) as a key factor to establishing a new field of interaction design. Within a few years, interaction design has been strengthened as a design interactive product or use-related qualities of the digital artefacts (Sharples, Taylor, & Vavoula, 2010). These definitions have resulted in a new objective for the field of interaction design as they give convergence depth to product or artefacts, rather than "spaces for human communication and interaction". This statement is also acknowledged by Kaptelinin and Bannon (2012), who stated that:

“An explicit objective of interaction design should not only be helping designers create better artefacts, but also help people themselves create better environments for their work, learning, and leisure activities.”

Thus, the objective of interaction design should be helping the designer to create a better environment for them.

This research focuses on the best techniques of teaching and learning that can be realised in a computer model software so that it can serve as a useful tool for the teaching and learning process. The children with disabilities that are focused on in this

research are DS children who have LD that can be addressed in various ways. The problem with these children is that they have been marginalised in society and are not part of their society activities. Unfortunately, their abilities and capabilities are usually ignored and underestimated by society. Their needs are also given low priority and they frequently face barriers in normal work due to their impairment. DS children find it hard to achieve their potential and are very vulnerable since their social and educational needs are usually left unnoticed. Nowadays, innovation of new computing devices and its application greatly affects the life of many children with disabilities and it has become an essential requirement in many fields such as education, playing tools and as an improvement to the quality of life. For educational purposes, there are lots of interactive applications that have been developed and designed to provide fair educational opportunities to overcome their disabilities. However, it is still hard to find appropriate learning apps for DS individuals because their level of LD is quite severe. Even in Islamic education there is a lack of apps which are developed for the study of the Quran, especially for those with LD.

Based on the detailed explanations given above, this research is significant in having managed to identify a number of problems: (1) It is not easy to teach DS students since the way they receive education is different compared to normal students; (2) There is no absolute learning model as a guideline to teach DS students; (3) Although the market nowadays offers learning tools for LD students, the understanding of the problems faced by a DS student is very general and superficial; and (4) Lack of Islamic learning tools for LD in reciting the Quran especially for DS students.

This research is directed to explore the academic strength that DS students actually have, their abilities and skills as well as how IT (M-learning) can be employed as a

learning tool in their studies. This study produces a user requirement model as a guideline for developers to develop apps for DS students in line with their environment of learning. In this study, the process of reading the Al-Quran for DS students is described as a practice to consider the effectiveness of the model. DS students have been proven by researchers to also have basic learning skills like other children (Garrett & Crump, 1980; Bird & Buckley, 1999; Fidler, Hepburn, & Rogers, 2006; Burgoyne et al., 2012; Grieco et al., 2015). DS students are chosen because studies by Dodd and Thompson (2001), Roizen and Patterson (2003), and Cortiella and Horowitz (2014), indicate that DS children have the lowest capability in learning sessions, in terms of memory and physical movement. There is a need of effective framework to cater for DS children and support their learning environment.

In this research, the User Centred Design (UCD) technique is employed as the main guideline for the construction of the research study. Meanwhile, HCI targeted to child development is employed to understand the user and the M-learning Characteristic Framework by Martin and Ertzberger (2013), with a learning environment and learning style of DS as the outcome of the preliminary study which is employed as the base of framework (guideline model).

HCI for child approach is featured based on the usability need of researchers and designers to take into account all potential user groups, including minority groups such as the disabled. This means that the user has a very wide set of functions and characteristics which would include requirements in the UCD methodology, and there are additional ethical challenges and other factors in addressing these user groups. Many researchers have studied the impact of technology on children but there is less to be said or studied about the real needs of children who may have a strong influence on the

technology design. This should include not only experimental techniques, but also a method for effective communication between the researchers, product developers and the end users. The UCD and HCI for child methods can facilitate researchers and developers in the field to develop better special equipment, and also provide mainstream engineers with an effective and efficient way of including PWD in the group of potential users for their projects.

This study is carried out to create a user requirement model which can provide guidelines for the developers to build learning applications that are appropriate for students with DS. The environment of M-learning, which is accounted for as a base of apps construction, makes this technology one of the more favoured learning technologies nowadays, due to its portability and extremely user-friendly nature. A lot of apps that are produced by the Internet market could not meet the real needs of users with LD, especially those with DS. It is not easy to develop human capital without the necessary information with regards to DS students' liability. One of the main things to be managed in developing apps on DS learning is the creation of learning content in various presentation styles to accommodate the student's learning environment and learning needs. In the constructivist view of learning and teaching, the important issue in developing technology learning apps is how the apps can give the optimum result for DS students, so that they will be capable of handling the learning difficulties that they face over the years.

Therefore, this study will be helpful for developers to develop suitable apps for DS students. These apps can be a great application that is able to help teachers and parents, and assist the concerned parties to improve the learning of children with DS so that they are able to compete in the future (upon reaching adulthood). In addition, all the essential

data in relation to the academic skills of DS students can be employed to provide the information or guideline to develop apps, networking or M-learning tools for DS in Malaysia's society, especially in Islamic education for those with special needs education. They can also use this data to build a syllabus of learning that suits DS students.

1.3 PROBLEM STATEMENT

In this century, most children are healthy and normal, without any disabilities. But some children who are unlucky have to face such problems. Some of them will have LD caused by neurological disorders, brain injury, mental retardation and other causes. Students with LD and other high-incidence disabilities are known to struggle with managing and monitoring their learning process. LD is a condition that significantly hinders a person from learning basic skills or information at the same rate as most people of the same age. LD typically affects six general areas:

- Spoken language: delays, disorders, and deviations in listening and speaking;
- Written language: difficulties with reading, writing and spelling;
- Arithmetic: difficulty in performing arithmetic operations or in understanding basic concepts;
- Reasoning: difficulty in organising and integrating thoughts;
- Memory: difficulty in remembering information and instructions; and
- Social skills: difficulty in interacting and integrating with others.

People with LD may include persons with the following diagnosis: DS, Autism, ADHD, Global Developmental Delay (GDD), Cerebral Palsy (some persons with Cerebral Palsy have learning disabilities) and Specific LD; including Dyslexia (difficulties in reading and writing), Dyscalculia (difficulties with mathematics), Dysgraphia (difficulties in

handwriting, graphing, punctuation), and Dyspraxia (difficulties in motor skills, speech).

The children with LD that are focused on in this research are DS children. Children with DS usually have hearing problems, vision problems, communication delays, and lower IQ than normal children which cause them to not be able to benefit from classroom learning as a normal child would. In addition, studies show that they are in dire need of lessons that suit their ability level so that they are able to accept what they have learned. Thankfully, with the use of interactive learning applications, they are showing signs of positive development. This indicates that the use of computer-aided tools create an interest in teaching and learning for these children (Ortega-Tudela & Gómez-Ariza, 2006).

The problems which led to this study is that today's market offer a lot of interactive material but they cannot meet the learning needs required by DS children because of these children's lower mental and physical levels as compared to other LD students. Therefore, this causes the learning process among DS students in school to not be as encouraging due to the lack of interactive teaching material and learning aids, especially in the field of reciting the Quran. For reciting the Quran among DS children, there is a lack in research which focuses on the learning process and style (character or patterns of behaviour) that suit the academic skills of DS students. Furthermore, in the era of TEL and mobile technology, it is also a lack of research that serves as an effective intervention method to support learning for DS children.

1.4 RESEARCH OBJECTIVE

The main purpose of this research is to investigate and develop suitable learning tools utilising UCD and HCI for child principle through mobile technology for LD students, specifically for those diagnosed with DS. Besides that, the FDM technique is used to obtain the best user requirements. These principles and techniques could be utilised to maximise the learning process as well as improve the teaching process. The aim of this study is to assist the programmer and software (app) developer by providing the user requirement model based on the M-learning Characteristic Framework by Martin and Ertzberger (2013), and combine the outcome of the preliminary study as a guideline to develop a learning app for DS students. In addition, this study also contributes to the Muslim community by providing equal opportunity for children with DS to recite the Quran just like normal children do. To make it relevant with today's technology age, the aim is achieved by integrating it into a TEL technology in terms of mobile technology that will result in the development of interactive M-learning package tools. Apart from that, this research aims to contribute to the needs of developing learning aids for learning and teaching of children with DS, as the current existing teaching aids mostly lack the interactive teaching material to fulfil the requirements of learning for DS students especially in learning Quran.

The following are the research objectives (RO) of this study based on the current problems mentioned in the previous section, and in order to achieve the goals:

RO1: To identify factors associated with the learning process and the learning environment of children with DS.

RO2: To obtain the appropriate method for reciting the Quran (targeted to recognise *hijaiyah* letters) for children with DS.

RO3: To propose a model to assist students with DS in the learning process which uses their learning strengths.

RO4: To evaluate the acceptance levels against the M-learning prototype app among the DS children in the process of recognising the *hijaiyah* letters.

1.5 RESEARCH QUESTION

The principal research question (RQ) in this study is with regard to creating a good user requirement model that meets the requirements of learning for DS students by developing the M-learning apps to meet their learning needs. From the principal question, the RQ were derived for each RO in more specific terms as below:

RO1: To identify factors associated with the learning process and the learning environment of children with DS.

RQ1: What is the learning environment for DS students that is appropriate with their style of learning in order to cater to their academic skills?

RO2: To obtain the appropriate method to recite the Quran (targeted to recognise *hijaiyah* letters) for children with DS.

RQ2: What is the suitable method for learning and reciting the Quran for children with DS?

RO3: To propose a model to assist students with DS in the learning process that uses their learning strengths.

RQ3: What are the factors involved in formulating the user requirement model which is appropriate with the DS students' criteria and fulfils their learning requirements and needs?

RO4: To evaluate the acceptance levels against the M-learning prototype app among the DS children in the process of recognising the ***hijaiyah*** letters.

RQ4: What are the levels of acceptance against the m-learning prototype apps among the DS children in the process of recognising the ***hijaiyah*** letters?

1.6 RESEARCH SCOPE

In order to achieve the objectives of this study and to enhance the learning for DS children involving technology tools, this study will make use of the learning skills and learning environment of DS students from several care centres or nurseries, and schools in cities in Malaysia.

Besides that, the scope of the data only covers data concerning the cognitive learning environment such as learning skills and the learning environment for DS students, within the context of development of learning to improve the tools of learning. The data regarding the students' skill of learning will concentrate on the sensory aspects of learning which are: visual (eyes), auditory (ears), and kinesthetic (touch or hands-on) that are taken into consideration for the purpose of meeting user requirements and needs, and for development of learning tools for DS students. All the data collected was with regard to DS students who already can be taught approximately as early as six

years of age. The data will be analysed according to the FDM that is adapted in the UCD process, by means of interviews and surveys. This method will be employed to aid in the user requirement obtaining process by identifying the important requirements needed, which will serve as a factor for future improvements of the tool.

1.7 RESEARCH DESIGN

A research design is defined as a methodological scheme to examine all the issues that have been identified. This study has been divided into four main phases that are; first: understand and specify the context of users; second: specify the user requirements and needs; third: produce the design solution; and fourth: evaluate the design. In the first and second phase, the process of obtaining the best needs will be analysed according to the FDM technique. The method of this research design is developed according to the method adapted from the combination of UCD and FDM methods, which is outlined in Figure 1.1, while the details are discussed in Chapter 3.

UCD is an approach that supports the entire development process in which the activity is centred on the user and creates an easy to use application that will add value to the consumer. Industry surveys clearly show that the majority of projects that fail can be associated with user requirements that are incomplete or inaccurate. The biggest advantage of UCD is that it can provide or specify more precise user requirements.

The UCD process has two main components (Cowen et al., 2014):

- Defining user activities: The tasks and subtasks for each activity are derived from the system's functional requirements, operator duties, and job workflows. Subtasks, tasks, and activities are validated for activating system functions to achieve mission goals.

• Create specific interface layouts that support user activities: UCD offers a repeatable process that iteratively evolves the design and layout of the interface by continuously engaging the end-users and other subject-matter experts.

The traditional Delphi method, developed by Dalkey and Helmer (1963), has been widely used to obtain a consistent flow through the results of the questionnaire responses (Adler & Ziglio, 1996; Chang, Tsujimura, Gen, & Tozawa, 1995). Delphi is a method that gets an expert opinion survey by three features: anonymous response, iteration and feedback control, and eventually statistics group response. However, some weaknesses have also been exposed, since it is necessary to study repeatedly to allow the gathering prediction, which requires more time and cost (Chang, Huang, & Lin, 2000; Winzenried, 1997). Furthermore, in a real situation, consideration experts' cannot be correct in quantitative terms. Some ambiguity will lead to differences of opinion on the meaning and interpretation by experts. Since people use linguistic terms, such as 'good' or 'very good' to reflect their choices, combining the concept of fuzzy set theory and Delphi was proposed by Murray, Pipino and van Gigch (1985), and named FDM.

FDM is a method which is generally used by researchers in various fields of Science, Technology and Management. The method has been described by Ishikawa et al. (1993) as the integration between the traditional Delphi technique and the theory of fuzzy sets. There are many methods of fuzzy Delphi such as FDM basic, fuzzy Analytic Hierarchy process (FAHP), and the distance (DIJ) between the two triangular numbers (Chen, 2000). FDM is required because of its benefits that integrate the fuzzy set theory with the Delphi method, whereby it consists of several steps that must be followed to obtain the approval of experts. It can solve the problems that arise in the traditional Delphi

method. This method speeds up the process and reduces the Delphi cycle. Furthermore, the evaluation also uses the value from 0 to 1 (Binary Term) in the assessment process.

As with other methods, to maximise the advantages of UCD, UCD activities should be integrated with the activities of other developments. It must be planned and better managed. Therefore, the consolidation method of UCD and FDM is seen as a very convenient method to enhance the project as both methods have the needs of the end user as the primary mission.

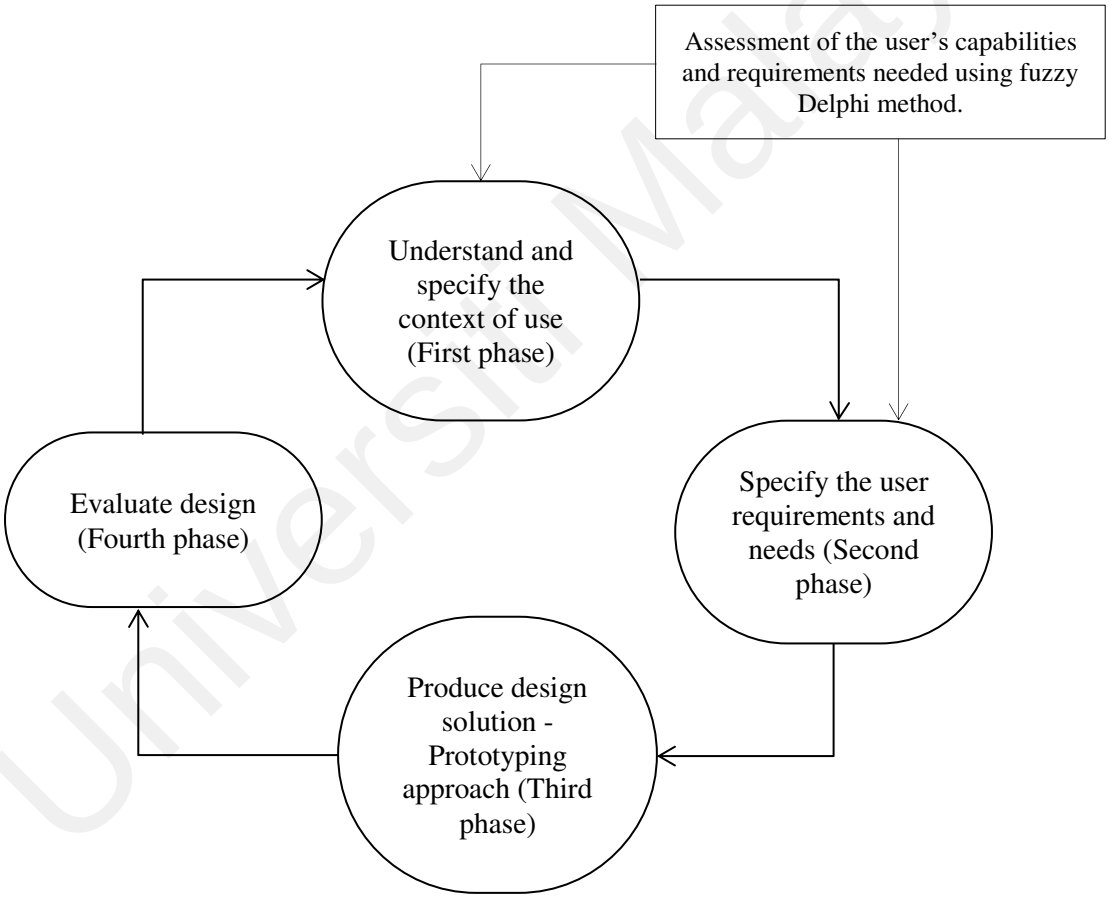


Figure 1.1: The user-centred Fuzzy Delphi design process.

This design process emphasises on the collaboration between the UCD process and FDM perspectives which are needed to ensure the system development is a success. In other words, the current UCD is heavily concerned with human needs (physical and cognitive capabilities, emotional needs, personality traits and situational factors)

whereas FDM methods try to meet the rules of learning (curriculum) that cater to the real needs of users. Therefore, the resultant of both of these methods is vital to understand the methodology and learning environment that meets the needs of those with LD. The first and second phase involve a review of earlier research literature concerning the end user, the academic environment, methods related to the learning process, technologies that can be used as aiding tools in the learning process and other related topics. Using the FDM method, an interview was conducted to gain information about the end user criteria and their learning process. The phase involves the development of preliminary factors with regard to the academic skills of DS students and the proposal of a user requirement model. In this phase, the tools for data collection are formulated for the FDM model. This phase also involves an analytical study that is carried out to answer the research questions. This is aimed at finding the main factors that influence the academic skills of DS students and their learning process environment. It is also aimed at developing a user requirement M-learning model as a guideline for the programmer or app developer to build an appropriate learning app to cater to the learning strengths of DS children. In the design phase (third phase), a prototype model was developed to gain the liability of the model that meets the learning requirements of the end user. Finally, the fourth phase is aimed at verifying and validating the end product to fulfil the requirements and needs of DS students in their learning process.

1.8 RESEARCH CONTRIBUTION

The results of this study are important in order to understand the learning skills and environment of DS students in Malaysia, and discovering the awareness concerning the requirements and needs of DS students in their learning process. Hopefully, the user

requirement model that was built can assist developers in the development of learning tools for DS students so that they can enhance the learning techniques and improve the learning performance. The research investigates the important needs of the user requirement process that should be considered by researches, teachers and parents, as well as administrators in the special education unit under MOE in their attempts to understand the requirements needed and style of learning that are required by DS students. The data can be used by the special education unit in MOE to improve the learning among DS students so that they are able to compete in the current environment.

This study is the first attempt at using a combination of the two techniques of research called UCD and FDM, which introduce the data acquisition process by FDM to complete the user requirement process in UCD. This technique is suitable for a small sample size and the variables governed by the ambiguous relationship. Furthermore, all the factors for learning skills are under the sensory learning discipline that covers visual (eyes), auditory (ears), and kinesthetic (touch or hands-on). In this way the research will be able to contribute to the enrichment of the TEL for teaching and learning purposes, in understanding and enhancing the development of learning tools for DS students. It is hoped that this research can serve as a guide or framework to build good learning and teaching tools for LD students and thus, help them to achieve success not just in their studies but also their personal lives.

1.9 THESIS OVERVIEW

This thesis has been organised into the following chapters:

Chapter 1: Introduction

This chapter provides a discussion on the basis of the research. It contains the research background (overview), statement of the problem, research objective, research question, research design, research methodology and contribution of the research.

Chapter 2: Literature Review

This chapter provides literature review about the background of DS children and their environment of learning, VARK learning style, learning principles and strategies, learning the Quran for people with special needs, TEL, M-learning technology, HCI for child and summary.

Chapter 3: Research methodology

This chapter explains the overall process used to develop in this research. It also describes the prototyping model approach. In addition, it also discusses the data analysis method and explains the implementation of the analysis.

Chapter 4: Data collection and Analysis

This chapter explains the methods employed for collection of data and a summary of the data analysis methods used. It also includes an explanation of the implementation of the analysis. This chapter also discusses the significant results collected from data analysis.

Chapter 5: Model and System Design

This chapter describes an explanation of the user requirement model used in the prototype of M-learning apps. This chapter also explains the system architecture and system design of the apps, followed by an explanation of the sketching menu screen used in the prototype.

Chapter 6: Prototype and evaluation

This chapter discusses the implementation of the app prototype. This chapter also describes the prototype components and its execution to brief the way the software runs. Besides that, it includes the evaluation process that determines whether the development process fulfils its requirement and usability.

Chapter 7: Discussion and conclusion

This chapter presents the main discussion, summarises and concludes all the contents and contributions of this research. This chapter also identifies and describes some aspects for future work in the same line.

CHAPTER 2: LITERATURE REVIEW

2.1 CHILDREN WITH DISABILITIES IN MALAYSIA

Malaysia ratified the convention on the CRC in 1995 with several reservations, of which five remain. To uphold its obligations under the CRC, Malaysia enacted the Child Act 2001. In 2008, Malaysia enacted the PWD Act; and in 2010, the government ratified the convention on the CRPD with two reservations. The rights of children with disabilities for care, protection and development are subsumed primarily within the Child Act and the PWD Act, and fall under the constitutional umbrella of protection of fundamental liberties under the Malaysia Federal Constitution. The key national stakeholders that provide programmes and services for the care, protection and development of children with disabilities are the SWD under the Ministry of Women, Family and Community Development (MWFCD), MOH and MOE.

In November 2012, Malaysia, together with other members of the UNESCAP, adopted the Incheon Strategy to "Make the Rights Real" for persons with disabilities in Asia and the Pacific ("United Nations Children's Fund (UNICEF) report", 2014). The Incheon Strategy comprises 10 goals, 27 targets and 62 indicators for improvements on the quality of life and the fulfilment of the rights of PWD, which include strategies for expanding early intervention of children with disabilities, strengthening social protection and enhancing accessibility to the physical environment, public transportation, knowledge, information and communication. One of the key principles and policy direction of the Incheon Strategy is "respect for the evolving capacities of children disabilities and respect for the right of children with disabilities to preserve their identities."

The national legal and policy framework in Malaysia does not have one definitive classification of disabilities. Malaysia's PWD Act states that persons with disabilities "include those who have long term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society." Meanwhile, the MWFCD has specific categories of disabilities of registering persons with disabilities; that are: 1. Hearing disabilities; 2. Visual disabilities; 3. Speech disability; 4. Physical disability; 5. Learning difficulties; 6. Mental disability; and 7. Multiple disabilities ("United Nations Children's Fund (UNICEF) report", 2014).

However, the Education (Special Education) Regulations 2013 provides special needs education for children with disabilities in Malaysia. The Regulation stipulates that a "pupil with special education needs" means a pupil who is certified by a medical practitioner, an optometrist, an audiologist or a psychologist to have: i) Visual disability; ii) Hearing disability; iii) Speech disability; iv) Physical disability; v) Learning difficulties; and vi) Any combination of the disabilities. The 2013 Regulations revokes the earlier 1997 Special Education Regulations, which restricted eligibility to the National Special Needs Education system only to children with special needs who were educable. Educable was defined as pupils with visual and auditory disabilities, and specific learning difficulties, namely i) DS; ii) Mild Autism; iii) ADHD; iv) minimal mental retardation; and v) specific learning difficulties (such as dyslexia). Physically handicapped children who were excluded in the earlier 1997 Regulation are now included in Special Needs Education in the 2013 Regulations (Nor, 2015). Based on the Department of SWD, Malaysia, there were 29,289 children with disabilities registered in 2012, and 19,150 from this number were those with learning difficulties, that is

65.4%. Therefore, the data shows that children with disabilities in Malaysia consist of those with learning difficulties.

2.2 BACKGROUND OF DOWN SYNDROME

As early as 1959, various studies had since been done to know about the ethology of DS. Studies find that the genotype of the mother and the embryo might have contributed to the effects of polymorphisms in the genes involved in foliate metabolism (Korenberg et al., 1994). According to Mao, Zielke, Zielke and Pevsner (2003), DS is caused by the existence of an extra chromosome or the third chromosome on chromosome 21, causing the total number of the chromosomes to be 47, and not 46 as found in normal individuals.

Shortly after birth, a baby with DS will be monitored for congenital heart disease, hearing loss, and ophthalmological problems. According to Roizen and Patterson (2003), about half of the DS children are born with a congenital heart disease. The most frequent lesions are atrioventricular septal defect (45% of newborns with DS) and ventricular septal defect (35%), isolated secundum atrial septal defects (8%), isolated persistent patent ductus arteriosus (7%), isolated tetralogy of Fallot (4%), and other lesions (1%) that can also arise. With the serious symptoms of heart disease, there is a possibility that a child with DS would not be able to (or has a slim chance) develop pulmonary vascular resistance. For hearing loss, which can be conductive, sensorneural, or mixed, between 38% and 78% of people with DS have this problem (Park, Wilson, Stevens, Harward, & Hohler, 2012). It is evident that children with DS are not able to hear very well and this results in their limited listening skills. It is similar with their physical levels as they are not able to do vigorous activities like other normal children because of their weak heart conditions and internal organs.

Ortega-Tudela and Gómez-Ariza (2006) also state that children with DS suffer from deficiency in learning and development. Such children tend to be less coordinated and have a lack of sufficient muscle tension relief, making it difficult for them to do everyday tasks and to engage in activities (games) like other children. DS children also suffer from memory deficit (Næss, Lervåg, Lyster, & Hulme, 2015), particularly in remembering what has been spoken by others, making it difficult for them to learn in school. They also have difficulties to clearly express their inner thoughts with words verbally (language skill), but most of them are able to learn how to read, write, and do simple arithmetic tasks after they have received proper education and good care. Most of the positive improvements in the quality of life of these children with DS is a result of strong support from their parents. Although initially parents may be a little apprehensive with caring for their DS children, with more recent exposure through the introduction and practice of various teaching and learning methods, the parents often report that their DS children are happier and more loving than other children (Cebula, Moore, & Wishart, 2010). Therefore, it is obvious that many individuals with DS can lead a productive life and bring a source of pride and comfort to their families.

2.2.1 Learning Disabilities of Down syndrome Children

Garrett and Crump (1980) state that learning disabilities or disorders in learning is a term to describe the disturbances faced by those with a disability in learning. Children with LD are not lazy or stupid, and their disabilities should not be an obstacle to their intelligence or motivation to study or learn something. Scruggs and Mastropieri (2000) state that the brain of those with LD have learning problems in terms of how they receive and process information. They have difficulties in analysing basic knowledge, and the most common type of LD involves problems in reading, writing, math, reasoning, listening, and speaking.

However, research has proven that the use of computer technology is able to support their LD as a spur to them to communicate and be involved in their studies (Chantry & Dunford, 2010; Cortiella & Horowitz, 2014). Dodd and Thompson (2001) have stated that children with DS also have problems in LD in which they need a method that needs to be adjusted so that it can be adapted to their learning styles in the learning process. They tend to be slow when giving answers in communication or asking sessions; cannot read and write very well, do not know how to count well; cannot speak and listen well; are easily bored with the same activity; find it hard to concentrate while studying and more (Roizen & Patterson, 2003). Children with DS are diverse in terms of personality, intelligence, learning styles and attitudes. Therefore, they should get the same attention and inclusion in society and education to develop their social skills and their academic knowledge. Therefore, a special style of learning, therapy, counselling, and special training should be provided in order to help them learn better (Feeley & Jones, 2008; Van Bysterveldt & Gillon, 2014).

2.2.2 Down syndrome and Learning Style

The development that occurs in an individual whether physically or spiritually is a result of his maturation process and experiences. Several theories of human development reveal that a human grows up from infancy to adulthood through a few phases of life. It is the children's abilities to interact with the environment that make them survive through those phases. So, the intellectual and emotional factors play an important role in one's life because the socialisation process needs to be actively experienced by the children. However, there are also some groups of children who suffer from cognitive development problems and social functions. One such group of children are those suffering from DS. These DS children have the same level of cognitive development as their social development. Although they often show a delay in language, they are also

motivated to please the people around them. Those suffering from DS, despite having serious retardation problems (slow development), usually have good character, and are happy, loving, and humorous. They are also able to adapt well in the community (Levis et al., 2012).

Skill is an action, task or a defined reaction pattern with a developed ability and willingness. This is a general character which depends on factors like genetics, environment, and learning. According to Lewthwaite and Wulf (2010), motor skill is the ability to produce a behavioural pattern related to a specific environment. Meanwhile, learning is a process to acquire skills and knowledge and to form attitudes. Motor skills learning involve processes in the sensory neurons and motor processes. This learning aims to obtain information, use the information, learn something, and do something. Fine and gross motor skills development of a child mostly depend on the development of the brain, balance, and improvement of the body's coordination. However, for special education children, it differs from normal children in terms of their mental and sensory capabilities; neural characteristics; muscular, physical, social or emotional behaviours; communicative abilities; and many other various aspects.

The intelligence level of children with DS, compared to normal children, is severely not at par. The level can be enhanced but to a limited extent when they are in their juvenile ages. In their post-juvenile ages, however, the growth of their intelligence level will usually not show any development. However, these special children are able to survive like normal people thanks to productive, systematic, and strategic teaching and learning (Fidler et al., 2006).

Students form a learning style since early childhood and then use that learning style to adapt to their lessons. Thus, a learning style practised by normal individuals is not different from these special students. The style of learning may be influenced by specific factors. A model in understanding the style of learning was introduced by Felder and Silverman (1988). His model is divided into four categories, namely 1. Active and reflective; 2. Concrete and intuitive; 3. Visual and verbal; and 4. Organised and global. Other than that, according to Wang and Chugh (2014), DS students tend to focus on facts, data, and algorithms. Some students respond strongly to visual forms of information, while many others prefer to learn actively and individually. Kozhevnikov, Evans and Kosslyn (2014) also suggest that instructors should pay attention to student-style learning in the flexibility of a cognitive style and the learning environment potential to reinforce the style flexibility in student learning. The use of multiple approaches is also important to help students understand the different learning styles they may use.

2.2.2.1 Listening skill

According to Fowler (1999), listening is a basic and vital skill in the process of communication, and it is an early skill acquired by children. The study also defines listening as one of the mental processes that give meaning to the spoken language. Furthermore, listening is obviously one of the most important skills that each individual must have. This is because listening plays a big role in communication and can determine the quality of a particular person due to the fact that listening skills can be a measure of one's competency (Thistle & McNaughton, 2015). Grieco, Pulsifer, Seligsohn, Skotko and Schwartz (2015) prove that even though children with DS have problems in hearing, with the aid of applications such as Frequency Modulated (FM) sound field amplification, they will be able to acquire listening skills. In a study done by

Park et al. (2012), it is also stated that if aggressive and compulsive treatment is given by both paediatricians and otolaryngologists as early as birth, the incidences of hearing loss in children with DS can be avoided. This proves that children with DS can hear and are capable of having good listening skills.

2.2.2.2 Reading and Mentioning Skills

According to the third category in the model introduced by Felder and Silverman (1988), the following are the characteristics of a student with visual traits: 1. A visual student prefers a visual presentation such as diagrams and flow charts; and 2. A visual student remembers things through sight easier. Next, the characteristics of a predominantly verbal student are: 1. A verbal student prefers a written explanation, or an oral one; and 2. A verbal student remembers things through hearing easier. From the research done by Burgoyne et al. (2012), it is stated that children with DS made slow but steady and significant annual progress in learning to read within a two-year period. The study also reported that children with DS progressed slowly with spelling because they have not achieved a level of reading, so the study suggested that these children should start early in reading to make a progress with spelling. Bird and Buckley (1999) also state that children with DS are learning to read and talk at the same time, the two skills interacting and informing each other. This can help students learn better. In a study conducted by Lott (2012), they find that regular speech and language therapy reassessments during childhood can ensure that all aspects of the language system are developed and used to facilitate interpersonal communication and language for thinking.

2.2.2.3 Recognising, imitation (repetition), and arranging (simple movement) skills

Based on the second category as presented by Felder and Silverman (1988), the characteristics of concrete learners are as follows: 1. Practical and oriented towards

facts and procedures; 2. Realistic; and 3. Attentive to detail. On the contrary, intuitive learners have the following characteristics: 1. Conceptual, innovative and oriented towards theories and meanings; 2. Innovative; and 3. Concerned about creativity in their work. Students with DS also have the same characteristics. They are meticulous and system-oriented, and some of them are creative in performing simple tasks and movements. The skills mentioned in this subtopic are the easiest basic skills for children with DS to grasp. According to de Menezes et al. (2015), individuals with DS tend to exhibit performance advantage under visual instruction. This visual instruction includes recognising skills, imitation, and making simple movements. The study by Melam, Buragadda, Alhusaini and Dhamija (2014) support this statement, saying that individuals with DS perform relatively well on skills involving visual demonstration but they require more time to process feedback.

2.2.3 Down syndrome and Reading Ability

According to Fletcher and Buckley (2002), children with DS were found to have measurable levels of phonological awareness. Their ability to read and to spell non-words was found to positively correlate with phoneme blending. Teachers should be aware that helping children with DS to acquire alphabetic skills should be a priority, but that their difficulties may be a consequence of their hearing and auditory short-term memory difficulties. Children with DS need to get early reading instruction to support their ability to read and write. DS children were found to have a good ability in reading and spelling, and the ability to use an alphabetic spelling strategy.

In addition, according to Verucci, Menghini and Vicari (2006), DS children show a particularly deficient reading ability. Therefore, it is important to raise and attract great interest among teachers or people involved in the rehabilitation work on the reading

ability in DS children. In any case, in order to foster a more rapid mastery of reading abilities in DS children, it is important to facilitate them in the initial phases of learning to read and write, also by using a strategy based on the global recognition of the written word.

According to a study from Roch and Jarrold (2008), results showed that although individuals with DS have impaired non-word reading and phonological awareness skills, the same relationship held between these two abilities was also observed in the group of typically developing children. Moreover, individuals with DS read at least as well as the typically developing children when the task required a visual reading strategy (reading irregular words). The results indicate that individuals with DS show an advantage of the visual route to reading over the phonological one.

Moreover, according to Ratz (2013), students with DS display a rather specific spread of achieved reading skills across all ages. The reading development of students with DS shows a strong emphasis on the alphabetic stage. Teaching these students to read by syllables seems a reasonable consequence, and requires offering word material with marked syllables such as bows beneath each syllable or syllables in different colours. Meanwhile, a study by Mengoni, Nash and Hulme (2014) provides evidence that the phonological aspect of vocabulary knowledge may help promote reading achievement, and therefore being presented with the spoken form of a new word before seeing it in print could be a valuable part of reading instruction for children with DS.

Additionally, the findings by Lanfranchi, Aventaggiato, Jerman, and Vianello (2015) show that individuals with DS were able to complete the training effectively, boosting their corresponding skills. There were also significant improvements in the areas of oral

and written calculation and numerical knowledge with medium effect size. Futhermore, the outcome study by Agheana and Duţă (2015) proves that through an individualized approach and with the use of modern means of education, children can acquire basic knowledge of mathematics, especially counting. This approach, one to one teaching and inclusion of children in situations of learning that motivates and makes them happy can improve the knowledge of children with DS, thus leading to the development of their school and social skills. Using the tablet, which allows the child to be in control of the learning situation and to operate at the speed he wants where there is complete visual and auditory support, can lead to progress in the acquisition of relevant knowledge in school and social context. The tablet is not associated with the effort involved in any ordinary school activity, the child is not pressed to give an answer and has enough time to process information and solve questions.

2.2.4 Down syndrome Strength Profile and Challenge in Learning Development

Research has shown that children and teenagers with DS not only take longer to learn new skills, but also learn different ways in some areas of study. Some teaching strategies that are different from the usual approach used in the educational system have been proven to be beneficial to those with DS. This includes approaches for numerical skills, reading, speech and language skills, as well as the use of restrictions and rewards in behaviour management (Buckley, Bird, Sacks, & Archer, 2006; Dykens, Hodapp, & Evans, 2006; Fidler et al., 2006; Fowler, 1999).

According to APPGDS 2012 (All Party Parliamentary Group on DS), children and young people with DS show:

- Relative strengths in social understanding and in relating to others, right from birth;

- Particular weaknesses in learning to talk, in using and understanding language, and achieving clear speech;
- Behavioural problems for DS is not an insurmountable feature in education because with the support of school and family as well as the basic requirements and good communication, it can be overcome;
- Strengths in visual memory with weaknesses in verbal memory skills;
- Strengths in reading;
- Differences in motor development which affect both gross and fine motor skills;
- Risk of specific health issues which affect development, in particular, thyroid deficiency, sleep difficulties, and hearing and visual impairments;
- Repeated periods of ill health and disruptions to life and learning, particularly during the first years of life; and
- There is a wide range in the needs and attainment levels of pupils with DS, and support must therefore be tailored to individual presentation and needs, while taking into account information about the impact of this syndrome on learning.

Figure 2.1 shows strengths and challenges associated with the main aspects of the specific learning profile for children and young people with DS, and the unique range of both physical and cognitive needs of this group of learners.

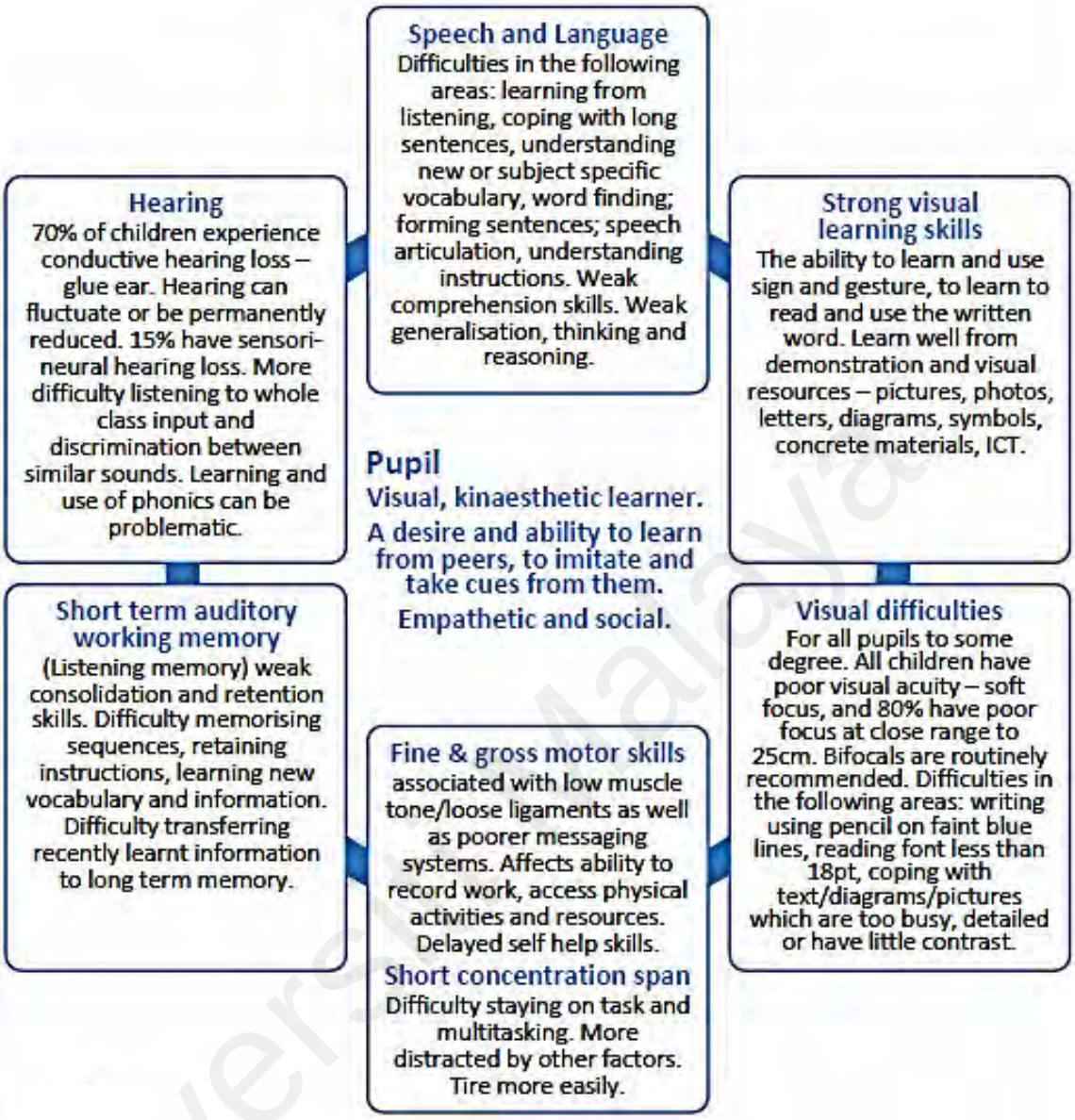


Figure 2.1: The Learning Profile: How DS Affects Learning by APPGDS, Education Advisory Group 2012

From the profiles above, it can be seen that children and young people with DS have a slower development stage in various areas including motor, social, communication, cognition and self-help. They require evaluation and support tailored to their individual learning profile from professionals who have the knowledge and experience in the learning profiles of children and young people with DS (Daunhauer et al., 2014). Research has shown that in mainstream settings, from early education to further education, success in learning development is dependent on the environment that

accommodates and supports them accordingly in society and the structure of education (Burgoyne et al., 2012; Marshall, Tanner, Kozyr, & Kirby, 2015). It has been seen that, with better practice, results in both mainstream and special schools can be enhanced to this group of students.

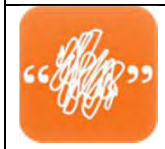
2.2.5 Analysis on Existing Learning Applications for Children with DS

In today's Internet market, there will always be learning apps that exist to meet the needs of users. Many interesting learning applications have been created creatively and innovatively by designers and developers. There are several entrepreneurs' learning applications that are dedicated to learning disabilities, especially DS, that include Jane Farrall (2012): iPads in Special Education, Gerry Kennedy (2010): The iPad as an inclusive device in education, and the DS Association of Queensland (DSAQ) (2011): The DSAQ guide to apps. Table 2.1 below is a summary of free learning application on the Internet specifically for DS children. From the analysis in the table, most apps available in the market are in the form of iPad, iPhone or iPod touch. and Android devices. But from the point of Islamic Learning Apps, there are very few apps for DS Muslims to learn and recognise the Quran (refer to Table 2.4 in Section 2.3 below).

Table 2.1: Analysis on Existing Free Learning Application in the Market

App Name / Icon	Device	Description
 Build It up	iPad	Develops fine motor and visual perception skills and concepts of size, position and order through assembling parts of an image correctly to create a whole image.
 The Playschool Art Maker	iPad	Develops fine motor skills through dragging and dropping favourite Playschool characters, and art and craft items into six different backgrounds to create a picture or narrate a story.
 Toddler Jukebox	iPhone iPod Touch iPad	Collection of all-time favourite nursery rhymes.
 Animals for Toddlers LITE	Android	This app is a beautiful app for small children. Now with six locations: farm, snowscape, desert-oasis, jungle, ocean and Australia. Tap the different animals to interact with them and hear their common sounds.
 Bob Books #1	iPhone iPod Touch iPad	Phonics-based interactive game that helps children learn to read by introducing new letter sounds through repetition and short stories.
 Tippy Talk	Android	This app is a communication tool for persons living with verbal disability, from the limitations of same room communication and opens the door to the world around them. This app allows communication by translating pictures into text messages which are then sent to a family member or caregivers phone or tablet.

Table 2.1: Analysis on Existing Free Learning Application in the Market (continued)

Apps Name / Icon	Device	Description
 Goodnight Safari	iPhone iPod Touch iPad	Children are encouraged to help prepare animals for bed by tapping on baby animals to complete their activity. The narration has an on/off feature.
 Sounding Board	iPhone iPod Touch iPad	This app is designed to assist the communicative needs of those with speech or language difficulties by creating communication grids consisting of words, photos and speech.
 ABC for Kids Alphabets	Android	A very fun way for toddlers to learn English alphabets. Full ABC: all alphabets include letters A to Z and are fully-featured. Multiple words per alphabets for better co-relation of letter with words. Real sounds associated with words with human pronunciations of all alphabets.
 Rocket Speller	iPhone iPod Touch iPad	A spelling app that is fun and interactive. Correctly place the letters to spell words to move through the game, consisting of four levels of difficulty, to successfully help Zip build a fancy new rocket ship.
 Scribble Press	iPad	A book creation platform allowing kids to create and share their own stories with writing templates and drawing tools.
 TalkTablet - Speech/AAC app	iOS, Android, Kindle Windows	TalkTablet is a fully-featured AAC speech/communication solution for people who have difficulty in communicating as a result of autism, aphasia, Down Syndrome, stroke or any other condition that affects a person's ability to communicate effectively.

2.2.6 Differences between an iPad and an Android tablet

The biggest difference between the iPad and Android tablets is the operating system since the iPad runs on iOS while Android tablets run on Google's Android; both started on smartphones and are now being used in tablets. The biggest selling factor for the Android tablets against the iPad is Flash. Flash is the most popular software that is used to show online videos; aside from other things it can do. The iPad cannot show videos from YouTube and a lot of other sites due to the lack of Flash. You also cannot install Flash in the iPad by any means.

Another difference between the two is multi-tasking. Up until iOS 4, multi-tasking was clearly absent in the iPhone. iOS 4 introduced a tweaked version of multi-tasking to both the iPhone and the iPad. It is tweaked because only some applications have it and switching to another application actually means that the other app gets ‘paused’. Android tablets have true multi-tasking where applications run in the background while you are using another application. There is also no coding requirement in order to take advantage of multi-tasking so the makers of apps need not bother themselves with that extra step. Table 2.2 shows the strengths and weaknesses between iPad and Android tablets.

Table 2.2: The Strengths and Weaknesses Between iPad and Android

iPad		**Android tablets**	
Strengths	Weaknesses	Strengths	Weaknesses
Tends to be more stable, easier to use and runs smoother than other tablets.	iPad users are largely stuck with the same uniform rows and columns of icons.	Customization options to the users: customize the device according to requirements.	Is not quite as simple and intuitive as Apple's iOS to use.
For non-technical users, it's a powerful, easy-to-use operating system with an intuitive interface.	Multitasking is absent in iPad, i.e. when one application is used in the presence of another, it becomes paused.	The availability of a wide range of products providing excellent options from both premier and lesser-known brands like Samsung.	From the huge number of apps in Google Play Store, it has fewer apps that are optimized for Android tablets. Google allows tablet users to also install third-party apps.
iPad enables some close integration between devices and platforms.	While it is great that each app is checked by Apple for approval prior to its release into the App Store, some useful apps are locked out in this approval process.	Android tablets make it possible to swap out your default browser for a newer one.	Does not pre-check the apps as Apple does before taking them into the store. This occasionally leads to some malicious apps sneaking through.
The Apple 'App Store' has a long list of downloadable apps that includes every popular app. These apps include wireless keyboards, tablet cases, external speakers and many more.	Unable to expand its storage capacity through micro-SD cards in absence of any card slot, which means when it runs out of storage space, it is really out of space.	Android's 'Google Play' marketplace has also made a lot of progress in the past few years. It has now a huge number of apps with a lot more choices.	
Apple only officially supports and allows applications to be installed through its own store: eliminating the possibility of malware/bugs to get into the device.	Flash or Shockwave videos cannot be run on its platform.	Another advantage of tablets running on Android OS is that they have true multitasking.	
It is easier to post updates and share on social networks using iPad.	More expensive than other tablets.	The storage capacity of Android tablets can be expanded through Micro SD cards.	
		The Android device is cheaper than the Apple iPad.	

2.3 LEARNING THE AL-QURAN FOR THOSE WITH SPECIAL NEEDS IN MALAYSIA

Al-Quran al-Karim is a book of guidance that guides people to return to Allah to accept their primary role as the caliphs of Allah on Earth. The Holy Quran contains guidance in following the norms of life and guidance for the people. The practice of reading the Quran is a requirement and it is also an obligation on Muslims to proficiently read the Quran, let alone understand and practice it. However, for those with learning and other disabilities, it is very difficult to learn the Quran. Although the implementation of a teaching method for these special people is a difficult thing, it is a claim to all to ensure that their right to read the Quran is not neglected (Ahmad & Abu Hanifah, 2015).

In Malaysia, issues that exist in the teaching of Islamic education in the Special Education program in schools comprise aspects of academic qualifications and professionalism of teachers, knowledge of the characteristics of special needs of students, and the ability and confidence of teachers to deliver the contents of Islamic education to students with special needs, as well as the need for infrastructure supporting the teaching and learning of Islamic education (Ahmad & Abu Hanifah, 2015; Yasin et al., 2013). Teachers who teach children with special needs should have teaching skills appropriate to the learning needs of students according to the category of disabilities (Scruggs, Brigham, & Mastropieri, 2013). For example, visually impaired children use Braille machines to write and read materials in Braille, including the Quran in Braille. Therefore, teachers teaching Islamic education for blind students and severe vision problems need to have the ability to use Braille machines and read Braille texts, especially Braille Quran (Raus et al., 2013).

The study also shows that teachers cannot focus entirely on teaching the Quran recitation specifically; instead teachers are more focused on completing the syllabus for examinations, so the emphasis on Quran recitation is lacking. Besides that, the time allocated for the teaching of the limited Islamic education subjects causes teachers not to emphasize the reading of the Quran but emphasis is only given to teaching '*tajwid'* which is one of the scopes of the examination questions or components of Islamic education. This has resulted in the ability of students who read the Quran well cannot be improved because focus is only on the examination syllabus while the Quran reading test is not implemented in the national examination system. The same goes for normal student schools, in which curriculum emphasis is still geared towards the orientation of the exam. Teachers of Islamic education should complete the syllabus according to the set time (Razak & Ngah, 2002).

In addition, studies also found that teachers do not have a wide range of resources for teaching aids to teach the Quran. Besides that, parents tend to completely leave the teaching duties to school teachers without monitoring the children at home. This makes the task of Islamic education teachers more difficult and causes a heavy burden, especially in the field of Quran recitals. Studies have found that if students receive additional instruction in addition to what they receive at school, this will help them to master some subjects (Ismail, Khairuldin, & Mohammad, 2014).

Table 2.3 shows the description of the method of Learning Quran among PWD in Malaysia.

Table 2.3: The Description of Methods of Learning Quran among People with Disabilities

Type of disabilities	Method of Learning Quran	Description
Group of Deaf and Speech disabilities	Faqeh Method	For reciting the Quran with this group, they have the Faqeh method, which is a sign language method that was introduced by Teacher Nor Aziah Mohd Daud.
Visual disabilities	Al-Quran Braille	
Learning difficulties – Autism	Many apps	Autism has been studied by many researchers and there are quite a few apps that can meet their learning needs in the market right now.
Learning difficulties – DS	Lack of apps	DS has many disabilities such as slow development and short term memory, and there is a lack of researchers that study them for Islamic education.

Based on Table 2.3 above, it shows that in terms of Islamic education, DS students do not have favourable attention from the community because of the judgmental opinion that these DS children do not need religious education like other normal children. There are a number of applications produced to support the learning of the Quran among children in general. Table 2.4 presents an analysis of some of the existing Al-Quran learning apps that have been taken from the Google Play Store. Based on the table, some of the learning activities that are always implemented in the app have been identified, namely drag and drop, touch and listen, puzzle, memory block, writing and tracing, and displaying video. Among all the learning activities used, touch and listen are the favourite activities that most designers have always approached in their apps. Some apps do not provide the exercises related to the lesson content. Therefore, the child's understanding of the lessons taught is difficult to assess. In fact, it will cause boredom in children as it is less interactive and unattractive. This factor cannot attract those with LD, especially those who have DS. Additionally, the selection of colours, backgrounds, layouts and sounds play an important role in ensuring the app is attractive, fun and engaging for the use of DS children.

Table 2.4: Analysis on Existing Al-Quran Learning Application from Google Play Store

Application	**Content**	**Learning Activity**						**Reward**	**Error Sign**	**Comment**
		Drag and Drop	Touch and Listen	Puzzle	Memory Block	Writing Tracing Lines	Displaying Video			
Marbel Hijaiyah	Hijaiyah letters -Lesson -Exercise	√	√	√	√	√	-	√	√	-Fun and cheerful background and layout -Colourful with various interesting characters -Interactive
Iqra'-Reading Al-Quran	Hijaiyah letters -Lesson -Exercise	-	√	-	-	-	-	√	√	-Fun and cheerful background and layout -Colourful with interesting characters
Alif Ba Ta	Hijaiyah letters -Lesson	-	√	-	-	-	-	-	-	-Not interesting (looks like digitalized flash card) -Less interactive
Quran Puzzle	Surah Al-Fatihah -Lesson -Exercise	√	√	√	-	-	-	-	-	-High level learning -Specialized for memorising Al-Quran
Elif Ba Lernspiel	Hijaiyah letters -Lesson	-	√	-	√	-	√	-	-	-Not interesting -Less interactive

According to Narayanasamy et al. (2002), people believe that religious and spiritual education for those with LD is difficult because of their natural defects (Narayanasamy, Gates, & Swinton, 2002). Studies on the religious education system for those with DS was also found to be lacking. There are many existing studies on Islamic education but they do not focus directly on the real learning needs of those with LD, especially DS. There are many scientific articles found under the keyword of religious therapies for DS but most of them explain how families and parents of those with LD, especially DS, face pressure with the religious approach of teaching.

In Christianity, King et al. (2006) state that religion is a very positive approach; going to church and getting closer to God can reduce the pressure faced by families for those with LD, particularly DS. In addition, some respondents in the study of Marks and Dollahite (2001) believe and are convinced that they have been chosen by God to have these children with DS or LD. For this reason, they are convinced to make their lives better and be stronger to cope with living conditions. With regards to Islam, a study by Ikromah (2015) states that the therapeutic approach of the Islamic version through reading the Quran and *doa* (known as prayer) plays an important role in making individuals such as those with DS live better, especially in terms of communication skills and emotional control.

2.3.1 Al-Quran Learning Technique in Malaysia

The importance of the Quran in the daily lives of Muslims is something that cannot be denied. However, there are many children in Malaysia who are still struggling with problems in learning the Quran. According to a study by Irnawati, Sarah and Zulkifli (2012), various studies and researches have been done such as the study done by Chik (1986), Muhamad (1992), and Noh and Tarmizi (2009), in which they stated that one of

the major factors that have been found is the inappropriate implementation and techniques used in teaching and learning the Quran among students. Teachers, parents and students need to be smart enough to choose the methods and techniques that are most suitable and appropriate for students, especially for those who have LD. There are many methods and techniques in teaching and learning the Quran. All learning methods and techniques have evolved rapidly in order to ensure that students can master the skill of learning the Quran by reading, memorizing and understanding the contents of the Quran. In Malaysia, there are a number of methods of learning the Quran that have been implemented specifically for children, such as Baghdadiyah, Qiraati, Iqra', Hattawiyah, Al-Baghdadi and Al-Jabari. Table 2.5 explains in detail each of these learning methods and techniques.

Table 2.5: Review on Al-Quran Learning Methods & Techniques Implemented in Malaysia

No	Method	History	Implementation	Strength/Weakness
1	Baghdadiah	From Baghdad. Introduced to Malaysia in line with the arrival of Islam a few centuries ago.	Using a book called ***muqaddam*** and emphasized on the ***Hijaiyah*** letters, line and spelling.	The arrangement of surah is in reverse order. The right manner in reading the Quran should be in order.
2	Qiraati	Introduced by Bapak Haji Dahlan Salim Zarkasyi; Semarang, Indonesia (1963).	Consists of five volumes. Begins with the introduction of ***Hijaiyah*** letters until the last volume for the higher lessons such as ***qalqalah.***	Students are able to master reading the Quran in a short time. However, it is not effective if there are too many students in a class.
3	Iqra’	Introduced by Haji As’a Humam; Yogyakarta, Indonesia (1984). Reached Malaysia (1994).	Consists of six volumes of Iqra’ books. Emphasizes on guidance and exercises. Each teacher will guide only 5 to 6 students at one time.	Students are able to master reading the Quran in a short time. However, it is not effective if there are too many students in a class.

Table 2.5: Review on Al-Quran Learning Methods & Techniques Implemented in Malaysia (continued)

No	Method	History	Implementation	Strength/Weakness
4	Hattawiyah	Introduced by Drs. Mohammad Hatta Usman (1974).	Reading the Quran based on ***Romanji.***	Temporary and only suitable for certain groups.
5	Al-Baghdadi	Introduced by Ustaz Qr Jalaluddin Bin Haji Hassanuddin (2009).	Learn the Quran by using a tool called "***Alat Ketuk***".	The "***Alat Ketuk***" is believed to attract children's attention to learn the Quran and make the learning process more fun and enjoyable.
6	Al-Jabari	Introduced by Drs. H. Yusof Sodik (1991). Reached Malaysia (2012).	***Hijaiyah*** letters need to be memorized through singing with Badr Nasheed (***selawat badar***) rhythm.	Attractive approach that influenced the psychological mood of students especially children.

2.3.2 Al-Quran Learning Technique for Down syndrome Students

Teaching and learning the Quran does not involve specific rules or methods. It depends on the methods and techniques of learning from previous scholars, and then modified according to circumstances and their environment (Amin Al-Muqri, 2012). The existence of all the existing methods and techniques is surely to help Muslims to learn the Quran and its meaning. However, most of the methods and techniques of learning the Quran is more focused on normal children or those who are normal and not for children with learning disabilities, especially DS. For this reason, their chances to learn the Quran is very limited because of the non-existent methods and techniques that are created specifically for them (Mohamad, Yusoff, & Adli, 2014). For children with DS, learning methods and techniques to recite the Quran must be in accordance with their interests and abilities, in other words according to the level of their disability to receive a lesson.

Basically, DS children require special attention and a different way of being taken care of, which makes it unlike the care of a normal child. It should be tailored to their cognitive level and also their physical abilities. People or societies often overlook this problem every time they try to establish methods and techniques of learning especially in reciting the Quran. For example, the technique of *Iqra'* and *Qiraati*, both of them are proved to be effective in helping children master reading the Quran in a short time (Priyanto, 2011). However, these techniques typically use a formal approach where it causes DS children to lose interest and get bored because they have very short concentration and also do not like to be controlled.

Besides the Iqra' and Qiraati techniques, the Hattawiyah technique was also designed to eliminate illiteracy of the Quran, especially among children. This technique introduces the Arabic letter (known as the *hijaiyah* letter) in the form of a letter *romanji* 'ا' to 'A', 'ب' to 'B' and so on. In order to implement this technique, the children need to recognise letters of the alphabet and know how to read in *romanji*. Therefore, this technique is not recommended and is not suitable for children with DS because most of them are unable to read even in the form of *romanji* itself. In addition, this technique will confuse the DS child because this technique does not maintain the length of reading the letter and hum of the Quran reading correctly.

Currently, Al-Baghdadi is a technique well known in Malaysia which emphasizes the concept of learning the Al-Quran by using a tool called "*Alat Ketuk*" (tap tool). This tap tool is a small instrument that helps students to establish and improve their pronunciation when reading the Quran. This is seen to be very creative, innovative and reliable so as to attract the child's attention while learning the Quran and makes the learning process more enjoyable and impressed. However once again, this technique is

not recommended for children with DS because their psycho motors are very weak and they face difficulties in producing the accurate beat. As a result, the learning process with this method is limited and less attractive to children with DS.

One more technique used in Malaysia is the Al-Jabari technique. Unlike other techniques, this technique uses the singing approach to attract children in the process of learning the Quran. The core learning in the Al-Jabari technique is focused on the Memory Mind Mapping, which is ***hijaiyah*** letters sorted based on Arabic words that carry a particular meaning (see Figure 2.2). Moreover, the children have to memorise the ***hijaiyah*** letters through singing the ***Badr Nasheed*** (***selawat badar***) rhythm. The repetition of the song is one of the most interesting approaches that is highly recommended as a teaching pedagogy for children with learning disabilities because through singing, they will find it easier to memorise and recognise the ***hijaiyah*** letters well. Thus, the learning techniques of Al-Jabari was found as appropriate and relevant to recite the Quran for children with DS because it is a technique that can be suitable to implement; through a singing technique that may interest them to learn and always keep them in a happy mood to learn the Quran.

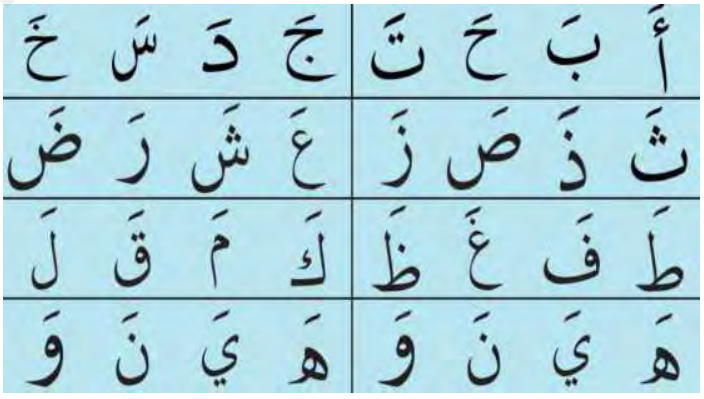


Figure 2.2: Abahata (Al-Jabari) Technique-Memory Mind Mapping

2.3.3 Advantages of Abahata (Al-Jabari) Technique

The technique of learning the Quran by the Abahata (Al-Jabari) method is a technique that is easy and fun to capture the recitation of the Quran, especially in recognising *hijaiyah* letters. It is very suitable to be implemented for all ages including adults, children and individuals with special needs. The main strength of this technique is that it emphasizes *hijaiyah* letter sounds and pronunciation through singing according to the rhythm (*Badr Nasheed*), which is an interesting rhythm, at the beginning of the learning process. Recognition of the *hijaiyah* letters and knowing the pronunciation of each letter is key for a person who learns the Quran because it allows better reading or reciting of the verses of the Quran. Another advantage of the Al-Jabari technique is that it contains many elements that complement each other because it combines the mastery of reading and writing skills. According to Irnawati et al. (2012), in a study that was carried out earlier, there is no other technique that combines any two skills that is reading and writing skill as a way of learning the Quran.

In addition, teaching materials and learning using the Abahata (Al-Jabari) technique is set up gradually and systematically, from simple to average and to the difficult stages. In other words, it is a technique that follows through the process of identification, understanding and mastery. For good lesson of content, the Al-Jabari technique provides materials including reading, writing and knowledge of "*tajwid*" recitation. Thus, this technique provides opportunities for students to be independent and at the same time work with others as a key of learning and teaching. Mastery of this technique is through observing, reading, and then imitating as well as writing.

The successfulness of the implementation of the Quran program has led to the use of the Abahata (Al-Jabari) technique that spread widely throughout Indonesia and Malaysia. In

Indonesia, the Ministry of Religious Affairs incorporated this technique in a reference book of Al-Quran Literacy and is often presented in meetings with teachers across Indonesia. While in Malaysia, this technique was first implemented at the Tun Abdul Aziz Mosque in collaboration with the Centre Quranic Research (CQR), University of Malaya. Participants in the program under the supervision of the mosque are *muallaf* (Muslim converts) from the Philippines, and they can master reading and writing the Quran after 30 sessions of learning using the Abahata (Al-jabari) technique.

Besides that, the Tun Abdul Aziz Mosque with Akademi Fakih Intelek also implemented this technique to students who are autistic. This group of participants also show good progress as they learnt Quran with this technique (googlevideo.com/ Testimoni Al Jabari - Pelajar Akademi Fakih Intelek Autisme). Under the Fakih Project, CQR, they have a Quran class for special needs, where they applied the Abahata technique with special needs. However, the centre only has two DS students, thus researcher would like to see the impact of the Abahata technique to more DS students.

2.4 SENSORY LEARNING MODELS – VARK LEARNING STYLE

The VARK learning style model is a learning style that has been modified from the VAK model by Fleming in 2006. The VARK learning style is modified by classifying students into four different modes. According to Chang, Chuang and Kuo (2012), Fleming's VARK model stands for Visual, Auditory, Read/write, and Kinesthetic. Fleming claimed that visual learners (V) have a preference for graphical information, such as maps, spider diagrams, or flow charts. Auditory learners (A) have a preference for listening information, such as lectures, tutorials, or tapes. Read/write learners (R) have a preference for information displayed as words, while Kinesthetic learners (K) prefer to learn via experience and practice, such as demonstrations, or simulations.

According to Yahaya, Ghaffar, Ramli, Boon and Hamid (2007), dividing students according to mode is necessary so that the effectiveness of each lesson to different VARK learning modes can be observed.

Fleming and Baume (2006) believe that to observe effectiveness and students' acceptance to learning that applies in the teaching and learning process depends on the students' learning style. The study also found that students' achievements on e-studies rely on the students' learning style. This obviously shows that learning style; visual, auditory and kinesthetic, is significant for academic achievement by observing their skills improving during the learning process (Vaishnav, 2013).

In a study by McNutt and Brennan (2005), on the tendency of students who used VARK in multimedia elements, the study found that visual students are more inclined to use text and graphic in multimedia elements. Moreover, auditory students prefer using text and graphic as well as audio applications in multimedia elements. On the other hand, kinesthetic students are more inclined to use text and graphic for assignments or gaming, as it requires hands on work by using the touch screen. Table 2.6 explains the tendency in each learning process of VARK mode.

Table 2.6: The Tendency in Learning Process based on VARK Mode

Mode	Tendency in Learning Process
Visual	Learning by looking at pictures, graphs, videos, and graphics. Could not take complete notes during presentation.
Auditory	Receive learning by listening method, speaking or through music, discussion, and explanation.
Reading/Writing	Prefer words and texts as an information obtaining method. They like presentation style, by text or writing.
Kinesthetic	More likely to experience through physical movements while studying, such as by touching, feeling, holding, performing and moving something. They prefer hands on work, practical, project, and real experience.

According to Othman and Amiruddin (2010), the VARK learning style does not involve intelligence or inherent skills but is closely related to how we acquire or understand information or new knowledge. The VARK learning style also can be perceived as an individual method that one uses for the purpose of acquiring knowledge, positive skills and attitude. As such, the VARK learning style can create a fascinating learning environment for students and stimulate students' senses in learning.

2.5 LEARNING THEORY AND STRATEGIES

Effective learning can be achieved through the principles and strategies incorporated in the development of the education system. Understanding how a person learns is important to understand how lessons should be taught to them. The most popular theory or principle is the principle of behavioural psychology, as it considers the learning behavioural changes that can be seen in the students themselves being a result of acts or events that happen to him (McGonigal, 2005). According to Sorathia and Servidio (2012), most psychologists and educators also add cognitive learning principles and the principles of the constructivist theory as learning principles that can potentially be used for students. Any of these principles or a combination of the three principles can be used depending on the learning objectives to learn or even the psychology of the students themselves.

2.5.1 Constructive Learning Theory

Constructive learning theory or "constructivism" is to emphasize the importance of the active involvement of the students in building their own knowledge, and develop new ideas or concepts based on current knowledge and past experience (Hein, 1991). Among the basic teaching and learning in the constructivism theory is a discovery (the findings), hands-on, by experiences, collaboration, project-based learning and

assignments (task-based learning) (Wood, 1995 in Abarbanel, Kol, & Schcolnik, 2006). Steele (2005) mentions in a study that students need to develop their own understanding of each concept or knowledge as a major role because the main role in the teaching process is not to lecture, explain, or rather trying to "transfer" the knowledge, but in fact it is for creating the conditions in which students can be encouraged so that they can carry out the learning activities required for the construction of a mental illness. According to Abarbanel, Kol, & Schcolnik (2006), based on the constructive learning theory, the main ideas can be used in teaching children with special needs which is related lessons to real-life situations that make ideas become even more meaningful. Furthermore, this idea designs educational activities that make or encourage students to participate actively and provides clear explanations as a guidance to facilitate the learning process to become easier (Savery & Duffy, 1995). These ideas can be exchanged and used in building the applications of learning software that will be useful for children with DS.

2.5.2 Behaviour Learning Theory

Behavioural learning theory or "Behaviourism" is based on the idea that all behaviours are derived from the prevailing attitude outright because of their interaction with the environment. To obtain knowledge, behaviourism is dependent on when the student has an interaction with the instructor or teachers (Mergel, 1998). The instructors or teachers must demonstrate the facts of knowledge, and then observe, measure, and modify student behaviour changes towards achieving the learning objectives. This is because, through the stimulation of the senses, the correct response from students will be achieved (Ertmer & Newby, 2013). Some of the main ideas that as a practice in the behavioural learning theory are firstly to break down the task into small segments. This is to show that the assignment or task can be performed in a much easier process.

Second, model, demonstrate and explain each step of the procedure or steps that must be followed. This includes many practices and activities that are related to the task. Finally, monitor and collect feedback for continuous learning. The main ideas of the theory of behaviourism is suitable to put into learning techniques for those with DS so that the application designed for DS children can help them to understand knowledge in an effective manner (Steele, 2005).

2.5.3 Cognitive Learning Theory

Cognitive learning theory occurs when knowledge or surrounding information is converted into useful knowledge where it can be stored in the long-term memory, or in other words, students learn through their experiences (Bruner, 2009). In understanding the learning process with the DS children, they usually have impairment related to cognitive ability hence they tend to have a lower cognitive ability than the average rate, where they have to start learning from mild to moderate knowledge. Purser and Jarrold (2005) have found that DS children have the ability to learn with the method of direct manipulation learning in the form of animation, objects, images and colours. They also like the lesson format that contains a simple verbal so they can understand the lesson better. In addition, most DS children can do their best in school or anywhere else when they receive support and encouragement from their family, along with therapy and improvement involvement program in the early stages.

According to a study by Smith and Jarrold (2014), the learning through 'play' concept is proven to be effective for those with DS in which this 'play' concept is used as a stimulating environment. Teachers and parents as facilitators also need to continuously plan for meaningful activities, and build activities that can attract their children to be interested in understanding and learning something. In addition, another method is to

learn in groups and individual sessions with teachers (Bandura, 2001). DS children can be encouraged to participate actively and explore learning optimally. For group sessions, children can learn to take turns and interact and communicate with their teachers and friends. For individual sessions, it is conducted one-to-one based on the planning education that is stated for each child. The value point here is to be the starting point in helping children to achieve the goals and objectives in learning through appropriate teaching methods (Yilmaz, 2011).

2.6 E-LEARNING

The term e-learning is popular in line with the more widespread use of application tool or web technology for learning. E-learning is an abbreviation of electronic learning. According to Zhang et al. (2004), e-learning is the technology which is reshaping knowledge and the way it is delivered as well. The Institute for Learning and Technology (ILRT) of Bristol University describes e-learning as the use of electronic means to deliver, help, and enhance teaching, learning, and assessment. Surjono (2011) defined e-learning as a delivery of learning materials using technologies in an open, flexible, and distributed learning atmosphere. It is expected to present learning materials that match students' learning styles i.e. visual, auditory and kinesthetic either globally or sequentially. The materials are deployed to anyone, at any place, and anytime. Meanwhile, the meaning of a distributed learning environment is one where teachers, students, and the materials are in different places so that students can access whenever and wherever (Laurillard & Ljubojevic, 2011).

According to Garrison (2011), e-learning does not present more of the same. Electronic communications technologies, with their multiple media text, visual, voice and their capability to extend interaction over time and distance, are transforming teaching and

learning. In this regard, e-learning has considerable potential to alter the nature of teaching and learning transactions. A study by Schrum et al. (2015) also gives a clear understanding that pedagogical content knowledge and technological pedagogical content knowledge are important in implementing new models of integrating e-learning. For those with LD, Savidis, Grammenos and Stephanidis (2007) stated that at certain stages of education and training, the combination of learning and playing can also be useful. The availability of alternative ways of content presentation, as well as the possibility of personalizing various aspects of educational and entertainment applications, play a critical role towards satisfying the needs and requirements of a user population with diverse individual characteristics. For students with DS, Kyriakou, Charitaki and Kotsopoulou (2015) stated that DS students with the help of e-learning technology tools can manage to live socially and achieve the objectives of the individual educational plan in the areas of motor skills, speech, language, reading, writing and memory.

The element of interactive learning in e-learning is the most popular element that is used in learning technologies. Interactive learning is a pedagogical approach that combines social networking and computing technologies (Yang, Chen, & Chen, 2007). It has grown in line with the use of digital technology and virtual communication. Starting around year 2000, the use of interactive technology in teaching and learning for students is wider and it has been actively pushing the use of pencil and paper used by past generations. Interactive learning can be the meaning of the learning experience. It is an approach where students get information through real experience or hands-on experience (Laurillard, 2013). Interactive learning can be described as a lecture-type learning. It is an active learning process when compared to the old way of lectures alone. In interactive learning, students use objects or technology to obtain information

while the teacher is not directly involved in providing information to them, in other words they do not need to be fed information but instead information is obtained by allowing them to find it with the guidance of a teacher (Martin et al., 2011). The teachers still need to provide early information to students, as well as the equipment needed for the whole process of learning.

Nowadays, technology enhanced learning tools in learning sessions are becoming more popular and very helpful to support learners in their learning. Kim and Hannafin (2011) stated that the use of technology in leaning sessions can enhance student learning and their achievement. This is approved in the research by Motschnig-Pitrik and Standl (2013) which says that TEL, especially in terms of user-centred aimed at students' development on the levels of intellect, skills, and attitudes, is effective in face-to-face education. TEL can provide added value in aspects such as motivation by course style, learning on the level of skills and attitudes, self-initiated learning, community building and improving students' interpersonal relationships.

2.6.1 Technology Enhanced Learning

The ecology of e-learning is the context and process of e-learning. In line with achieving quality education, the context and process must be attended to optimally. The core of e-learning context is a collaborative and constructive transaction of e-learning that is exciting from this perspective in that it enhances and enriches both content and context (Selwyn, 2010). The challenge is to design and create context with the appropriate level of social presence which is congruent with the content and reinforcement of the educational goal that will enhance cognitive presence and realisation of higher-order learning outcomes.

Technology offers many different ways to attract students to perform in the development of knowledge and skills (Godwin-Jones, 2010). TEL as a field of research is carried out as it is very convenient to bring together two areas of research, technology and education that mutually challenge each other. The educational system is considered as formal activities designed to assist individuals in learning and improving skills and knowledge of culture and society, and this creates a challenge for the technology (Wang & Hannafin, 2005). TEL is not yet a discipline and it has not yet developed a clear methodology, but it is a way of thinking that can determine discipline combined with technology and education (Chan et al., 2006). As a research field that stands at the interface between the two disciplines that are very complex, it becomes a struggle that extends to work to determine how and what is the best way for both of these fields to co-exist (Beetham & Sharpe, 2013).

According to Keppell, Suddaby and Hard (2015), their perspective of TEL and teaching aligned with that of Laurillard, Oliver, Wasson and Hoppe (2009), who viewed technology as a means of supporting new types of learning experiences as well as enhancing existing learning contexts. Moreover, the term from the study that is 'interactive and cooperative digital media have an inherent educational value as a new means of intellectual expression and creativity' provides the motivation to give the outcomes for the best practices in TEL and teaching. The researchers conclude with the best practices, which are:

- A focus on learning design allows academics to model and share good practice in learning and teaching

According to Keppell, Suddaby and Hard (2015), learning design has been defined in numerous ways. With the definition given by Conole (2013), learning design is a

methodology to enable teachers or designers to make plans or decisions on how to design learning activities and interventions, which are suitable to create the tools, especially in terms of technologies and design the resources and individual learning activities that meet curriculum-level design. In line with this definition, Keppell et al. (2015) stated that when reviewing projects, learning design is the best method in the design of activities, subjects, assessment and curricula. Therefore, the discipline of the projects is to be multi-disciplinary with generic approaches to design. This means that the projects which effectively implemented approaches that are focused on learning design will understand the importance of supporting academics to share and model the good practices. Projects which considered these elements from the beginning were also more successful in meeting their goals.

- Authentic learning provides a means of engaging students through all aspects of curricula, subjects, activities and assessment

According to Keppell (2014), authentic learning is very meaningful because it involves the students to act in real world activity, in subjects, assessment and curriculum and enables the transition to a learning environment that is more energetic. For the examining method, it focuses on the four key principles of authentic learning based on the study by Herrington, Reeves and Oliver (2014), that are: 1. Provide an authentic context that mirrors the way the knowledge will be used in real life; 2. Support collaboration; 3. Provide coaching and scaffolding by the teacher; and 4. Provide authentic assessment.

TEL can also refer to mobile technologies, which according to Kay's vision (Kay, 1972), computers became more personal and cost efficient. In the 1990s, advances in technology led to the creation of wireless devices like PDAs and phones that could

support mobile activity (Naismith, Sharples, Vavoula & Lonsdale, 2004). As devices became more capable and the size of devices became more manageable, a decrease in price enabled a large portion of the population to own personal wireless devices. The most common of these devices, the cell phone, remains the most widely owned and used today. Furthermore, prior reviews of m-learning studies have provided encouraging results for using mobile devices to support teaching and learning (Kukulska-Hulme et al., 2009; Vogel, Kennedy & Kwok, 2009; Yordanova, 2007).

2.6.2 Mobile Learning Technology

Mobile devices have only recently been recognised of its capability to perform as educational tools, although the concept of mobile educational devices was already established in the late 1960s by Alan Kay (Kay, 1972). In fact, Kay described a device that very closely resembles today's tablet PCs (e.g. Apple's iPad). According to Kennedy, Judd, Dalgarno and Waycott (2010), mobile phones are even more pervasive with university students, with over 97% of students born since 1980 being owners. M-learning is considered as the ability to use mobile devices to support teaching and learning. It is the mobile aspect of M-learning that makes it stand apart from other types of learning. This is due to the features and functions of mobile devices that create a supporting effect for the learners. As an example, students nowadays could download their own podcasts of lectures as they are now available for downloading. This has created a platform where they are expected to engage with these learning resources whilst being away from traditional learning spaces (Litchfield, Dyson, Lawrence, & Bachfischer, 2007).

The challenge for education continues to grow for students who were born in the digital era and as intelligence mobile technology are approaching learning. They are viewed

very differently from their predecessors where students are increasingly fond of using digital tools, and to build and share knowledge in new ways (Harris, Mishra, & Koehler, 2009; Sadik, 2008). Starting around the year of 2000, the use of interactive technology in teaching and learning for students is wider and it has been actively pushing the use of pencil and paper used by past generations.

Many studies have shown the benefits of learning with digital resources or tools but the thing that has been stressed is the need of 'authentic learning activities' where students can work with problems of the real world (Hwang & Tsai, 2011; Hwang & Wu, 2014; Wu, Hwang & Tsai, 2013). Previous researchers demonstrated the importance of students to be placed in a series of lessons designed to incorporate both a real and virtual learning environment (Hwang, Tsai, Tsai, & Tseng, 2008; Wong & Looi, 2011). The popularity of wireless communications and mobile technology have offered the opportunity to achieve such an objective (Lan & Huang, 2012; Chin & Chen, 2013). In this new learning environment, students can access digital resources and learn to interact with the system via handheld devices and wireless networks when they are in the context of the real world (Wu, Hwang & Tsai, 2013; Yin, Song, Tabata, Ogata, & Hwang, 2013). Such a scenario is known as mobile learning, which refers to “learning that occurs without capped at a fixed location” or “learning to take advantage of mobile technology” (Sharples, Arnedillo-Sánchez, Milrad, & Vavoula, 2009; Sharples et al., 2010). Meanwhile, Hwang and Chang (2011) stated that many computer-assisted learning strategies or tools might have the potential to serve as an effective mobile learning approach to enhance the learning achievements of students in a real world environment.

According to Park (2011), mobile learning is the next stage or a new form of e-learning through the use of mobile and portable devices, wireless network, and communication technologies for teaching and learning. Meanwhile, Ally (2005) stated that mobile learning is the process of using a mobile device to access and study learning materials and to communicate with fellow students, instructors or institution. On the other hand, Traxler (2007) defined mobile learning as a form of education that focuses on the learner's experience and provides a large number of learning opportunities on the strength of incorporated multifunctionality of mobile devices.

Kearney, Schuck, Burden and Aubusson (2012), highlighted three elements that characterise the pedagogy of M-learning: authenticity, collaboration and personalisation, as shown in Figure 2.3:

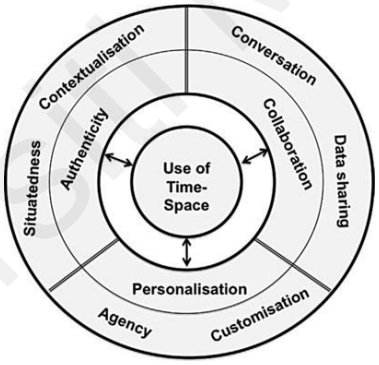


Figure 2.3: Framework of M-learning that was formulated by two sub-scales for each of these three concepts of element (Kearney at al., 2012)

The authenticity feature highlights opportunities for contextualised, participatory, and situated learning; the collaboration feature captures the often-reported conversational, connected aspects of M-learning while the personalisation feature has strong implications for ownership, agency and autonomous learning. These three features can help educators and researchers working in and examining M-learning contexts onwards to the development of learning tools (Kearney et al., 2012).

Additionally, the Joint Information Systems Committee (JISC) Mobile Info Kit (JISC InfoNet, 2011) introduces its pedagogical approaches discussion by the team to conduct mobile learning environments that are:

- Behaviourist – activities promoting learning as an observable change in behaviour;
- Constructivist – activities in which new concepts are actively constructed, based on a combination of previous and current knowledge;
- Situated – activities encouraging learning in an authentic context;
- Collaborative – activities encouraging learning through interaction with others;
- Informal and lifelong – learning activities outside dedicated, formal environments or curricula; and
- Learning and teaching support – activities which help to coordinate learners and learning resources.

A more holistic framework for mobile learning comes with Koole's FRAME model (Koole, 2009). This consists of a three-circle Venn diagram comprising the Learner aspect (L), the Social aspect (S) and the Device aspect (D). Taking two or more of these together at the point at which the circles overlap in the Venn diagram:

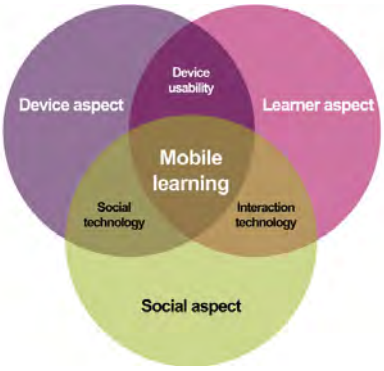


Figure 2.4: Koole's FRAME Mobile Learning Framework

Figure 2.4 shows the circles that represent the characteristics of the device, the learner, and the social. The Device aspect (D) takes into consideration the physical characteristics, input and output capabilities, file storage and retrieval, processor speed, and error rates. The Learner aspect (L) focuses on the characteristics of an individual such as prior knowledge, personal history, memory, emotions, learning styles, and ability to transfer skills and knowledge from context to context. The Social aspect (S) takes into consideration the processes of conversation and cooperation, the sharing of signs and symbols, as well as social and cultural beliefs and values. For the overlapped parts, one of which is the learner aspect that comes into contact with a device, which is Device Usability (DL) where it can consider elements such as portability, information availability, psychological comfort, and satisfaction with aesthetics and functionality. The Social Technology (DS) intersection is where it can consider how people, as a collection can interact with technology; in other words it is a means of networking, connectivity amongst systems and collaboration tools. The third overlapped part is Interaction Technology (LS), which is viewing how an individual is influenced by and influences the collective; in other words it can consider constructivist and constructionist ideas such as type of interaction, situated cognition and learning communities. Finally, at the centre of the model is the aspects and intersections forming the nature of the learning context. This is the point where it can be considered as a mediation, information access, and selection and knowledge navigation.

Meanwhile, according to Prieto, Migueláñez and García-Peñalvo (2013), the mobile application is the most frequently used app, particularly in terms of education. It is a kind of software application that is designed to run on mobile devices such as smart phone, tablet or any touchscreen device. Mobile applications typically provide the user with a similar service for all users such as WhatsApp, chats and so on, and it is also

easier for users to access information on the computer. The mobile application is typically small, light with limited and isolated functionality such as game, calculator, and mobile web browsing in various types of mobile software platform (Ebner, Stickel, & Kolbitsch, 2010).

However, according to Martin and Ertzberger (2013), they stated that M-learning keeps the learners engaged, and via the M-learning technologies, one is able to deliver learning that is authentic and informal. In order to represent the effect M-learning has on the learning environment, a three characteristic framework was created. Table 2.7 clarifies the characteristic framework.

Table 2.7: Mobile Learning Characteristics by Martin and Ertzberger (2013)

Characteristic	Description
Engaging	Engaging students in the context: The ability to engage learners because of its authentic learning and context based applications. Traditionally, engagement in education refers to specific procedures, strategies, and skills of the students. It has been argued that in today's current culture, a learning environment with interactive entertainment and ubiquitous learning environment is expected to have a high level of engagement during learning activities. So, mobile learning provides this engagement in new and powerful ways which allow consistent involvement with other professionals or other tools. This involvement increases engagement, and leads to authentic activities by participants.
Authentic	Authentic learning activities: In education, the knowledge should be situated within the context of authentic tasks because learning can be influenced in fundamental ways by the context in which it takes place. A mobile-based learning environment, by virtue of its portability, will provide scaffolding when and where students need it, whether in the classroom or in any learning environment. Mobile devices are available to be used in any context, and can draw on those contexts to enhance the learning experience. Mobile devices can support learners by allowing them to maintain their attention to the context and by offering appropriate assistance when required. These authentic learning activities also include many forms of informal learning.

Table 2.7: Mobile Learning Characteristics by Martin and Ertzberger (2013) [continued]

Characteristic	Description
Informal	Informal learning activities: Informal learning refers to learning that takes place naturally and without directed effort. In other words, learning occurs even without one knowing that they are in a learning session. Because mobile technology is the ability to work within the specific context and environment of the learning, it has the ability to increase the ease of informal learning.

From the discussion on M-learning above, the characteristic framework of M-learning by Martin and Ertzberger (2013) is correlated with the characteristics of DS shown in Figure 2.1. A student with DS is a student who has the strength to learn through demonstration and visual. Interactive learning activities can attract DS students to directly engage in learning activities that lead to the essential content of a lesson. In addition, DS students are also more likely to study unpretentiously without coercion or regardless of place or time. Repeated learning also helps the DS learners to learn well. Therefore, the element of engaging, authentic and informal learning is seen as very suitable for a learning environment among those who are DS.

2.7 HUMAN COMPUTER INTERACTION (HCI) FOR CHILD

How is designing computer software and hardware tools for children different from designing for adults? Many researchers have studied the impact of technology on children but there is not much to be said or studied about the real needs of children who may have a strong influence on the technology design. Swiss psychologist Jean Piaget is a key figure in analysing the development of cognition in children (Weisman & Safford, 1971). According to the study, Piaget suggests that children not only lack the knowledge and experience, but also experience and understand the world differently from adults. Piaget also divides the development of children into several levels: (i)

Sensorimotor (birth to 2 years); (ii) Preoperational (age 2 to 7); (iii) Concrete Operational (ages 7 to 11); and (iv) Formal Operational (age 11 and above).

Using age as a guide is useful; however, the designers should realise that designing for young people does not have the same problems as when designing for adults. Children are often aware of their own abilities where they prefer to go further and as far as they can accept it. Therefore, to interact with technology designed for children, it should not reach the level of tiresome (Antle, 2013; Hourcade, 2015).

In addition to considering the implications of cognitive development of children's ability to use technology, it is important to note that different age groups are different from their culture. Understanding what is fun or interesting for a particular age group involves understanding the abilities of children's development and cultural aesthetic feelings (Herrington, Oliver, & Reeves, 2003). Oosterholt, Kusano and de Vries (1996) suggested that designers be competitive with the rapid changes that are happening to children and should target a limited age range because the abilities and emotions of children also change quickly. Furthermore, the researcher will focus on some of the characteristics of the HCI research related to children: i) Agility; ii) Speech; iii) Reading; iv) Background of knowledge; and v) Interaction style (Bruckman, Bandlow & Forte, 2002).

The fine motor control of small children is not the same as adults and they are physically smaller. Devices designed specifically for adults may be difficult for children to use (Goyen, Lui, & Woods, 1998). The performance of children was assessed at different ages and with different input devices. For example, children may have trouble double-clicking, and their little hands may have trouble using the three-button mouse

(Druin, 2002). Inkpen (2001) stated that like adults, children can use point and click interfaces more easily, for example drag and drop game processes. The study also states that child software is often implemented to use a drag and drop interaction style.

A study by Thompson-Schill, Ramscar and Chrysikou (2009) states that young children cannot guess left and right directions, therefore, interfaces for children cannot contain or depend on these differences. In interactive toy design, toys that involve the feet and hands where it depends on left and right directions will always perform the same function. For example, interactive toys such as "My Pals" and the software interactive pad such as "LeapPad Platinum" by Leapfrog (http://www.leapfrog.com) depend on clear visual marks on the left and right feet to show different functions.

According to Kelly, Mazzone, Horton and Read (2006), HCI and Interaction Design, the term ‘design’ is not particularly well defined. Many studies use design in a broad sense, believing it to be a process that may include considerable implementation and analysis whereas it is clearly between analysis and implementation. Hence, the authors propose several guidelines for future use and the individual tools that are:

- The design sessions will take place out of the context of use. Therefore, ensure that you provide an effective context for the children to relate to. If your users are particularly young, be creative in setting the scene and using scenarios that they are familiar with. For example, show pictures of the context of use as reminders or prompts.
- Remind the children of their previous activities – try to re-use their knowledge or information that they have gained in the later stages of the designs. This will both help them recall their previous activities and also validate their previous efforts.

- Giving value to their previous work will make them feel accomplished in the design.
- Keep in mind that children are not designers and may not be able to express their opinions in 'normal' ways. Allow them to express their ideas in ways they are more comfortable with such as drawings and paintings.
- Collect ideas on the same topic in different formats such as words and pictures. This way issues can be explored in different ways and counterchecked against each other.

HCI for a child is very helpful for designers to design a technology that is appropriate to the ability of a child. In conclusion, the ability of a child to use a technology tool is limited. For example, designers need to use large images to design interfaces. Designers are also advised to use the drag and drop method without needing double-clicking. Additionally, designers are also advised not to use left and right directions as it can confuse children. Furthermore, the designer is also advised to build interactive activities involving pictures and sounds which can attract children to try and keep trying during their learning session.

2.8 THE USE OF FUZZY DELPHI METHOD (FDM) INTO COMPUTER STUDIES

Delphi technique is a technique that has long been used in a study involving experts (Winzenried, 1997). It is a method based on a group of experts who review and gather to form a consensus of opinion on such information. In short, it can also be considered a method to obtain structural data based on expert consensus (Hsu & Sandford, 2007). However, Siraj (2008) asserts that there are three weaknesses of the Delphi technique, which can cause doubtful data reliability if the researcher failed to elect a real expert.

Boredom will happen to the expert if the study was repeated and the number of experts used was too small to evaluate something big. This argument is strengthened by the views of Zeng, An and Smith (2007), which argues that the Delphi technique involves a long and repetitive study that could lead to a decision that is only subject to a small number of experts and is highly subjective. This controversy would invite the question of the inability of experts to assess and evaluate a large sample; in other words, it does not measure what is to be measured. To overcome this contentious state, the FDM technique has been used as a tool to get a great deal of experts. The strength of this technique is that it can reduce the length of the study period by reducing Delphi rounds. The use of fuzzy elements are integrated into the Delphi technique capable of analysing the agreement in only one round. Furthermore, Chang, Hsu and Chang (2011), holds that the strength of the FDM technique is that it is able to put the priorities and the elements of a consensual expert, while the construction of questionnaires is based on literature highlights that have been approved by the appropriate experts and data obtained after only one round.

A Fuzzy Delphi method is a method that employs fuzzy statistics and technique of the conjugate gradient search to fit membership functions. Membership functions besides triangles may be derived for fuzzy forecasts. Although the FDM method is widely used in education, there are many researchers from other fields such as computer technology that use this method to manipulate data and information for their projects. Table 2.8 shows the study on technologies that used the FDM method.

Table 2.8: Study on Technologies that used FDM method

Author/s	Title	Issue/Objective/Method	Finding/Research Interests
Chang, Tsujimura, Gen and Tozawa, 1995	An efficient approach for large scale project planning based on Fuzzy Delphi method	The goal of this paper is to replace probabilistic or deterministic considerations in the project network analysis by possibilistic ones and to reduce the difficulty arising from the inexact and insufficient information of activity times.	Triangular fuzzy numbers (TFNs) were used to reflect the reality of human judgment process in prediction. The Fuzzy Delphi method was applied to estimate a reliable time interval of each activity.
Shen and Hsieh, 2007	The Study of Fuzzy Performance Evaluation	An illustrative example will be also applied to demonstrate the effectiveness of the proposed procedure. As for the performance comparison, this study compares the difference between the actual performance and ideal performance while simultaneously taking all criteria into consideration.	From the deduction procedure and demonstration about the proposed multiple criteria decision-making (MDCM) based on fuzzy weight aggregation (FWA) and fuzzy performance aggregation (FPA), the weight value derived from the proposed MDCM will be more subjective and also be possibly identified by most practitioners.
Hsu, Lee and Kreng, 2010	The application of Fuzzy Delphi Method and Fuzzy AHP in lubricant regenerative technology selection	This study aims to provide a systematic approach towards the technology selection, in which two phase procedures are proposed. The first stage utilizes FDM to obtain the critical factors of the regenerative technologies and the second stage, Fuzzy AHP is applied to find the importance degree of each criterion as the measurable indices of the regenerative technologies.	This study considers eight kinds of regenerative technologies which have already been widely used, and establishes a ranking model that provides decision makers to assess the prior order of regenerative technologies. The empirical study indicates that the ‘‘Proper scale” is the most important evaluation criterion considered in overall experts.
Liu, Huang and Zhang, 2010	Research On Fuzzy Comprehensive Evaluation Of User Experience	This study discusses a fuzzy comprehensive evaluation method of user experience that is proposed to the problem on user experience quality which is difficult to accurately evaluate on the e-commerce web used.	In the evaluation of the C2C e-commerce sites’, user experience, not only the usability of sites, but also user-friendly and emotional experience would be taken into account. User research engineers that participate in the user-centered design (UCD) with professional background are useful to the transitional usability test.

Table 2.8: Study on Technologies that used FDM method (continued)

Author/s	Title	Issue/Objective/Method	Finding/Research Interests
Kabir and Sumi, 2012	Integrating Fuzzy Delphi method with artificial neural network for demand forecasting of power engineering company	The objective of the paper is to propose a new forecasting mechanism which is modelled by integrating Fuzzy Delhi Method (FDM) with Artificial Neural Network (ANN) techniques to manage the demand with incomplete information.	In this research, an artificial neural network (ANN) with feed-forward back-propagation algorithm was trained with the Levenberg-Marquardt algorithm (LM). The effectiveness of the proposed approach to the demand forecasting issue is demonstrated for a 20/25 MVA Distribution Transformer from Energy Pac Engineering Limited, a leading power engineering company of Bangladesh.
Radfar, Zolfani, and Nikjo, 2012	New Application of WeFA Framework and Fuzzy Delphi in Concert Locating	The main aim of this research is to identify important factors in selecting an appropriate place for a concert show.	This research applied Weighted Factors Analysis (WeFA) framework and Fuzzy Delphi for this aim and WeFA used for gathering data and Fuzzy Delphi for final evaluating of factors.
DeWitt, Alias, Siraj, Yaakub, Ayob, and Ishak, 2013	The potential of YouTube for teaching and learning in the performing arts	The objective of this study was to get consensus on the benefits of the use of YouTube as a tool for teaching and learning in the performing arts, and for maintaining students' interest and achievement in learning, as well as to determine the suitability of using YouTube as a tool for teaching the performing arts in future.	The findings of this study indicate the integration of information technology in learning and teaching performing arts can be done using YouTube. In the context of teaching and learning, YouTube is used as a video repository to assist both lecturers and students.

2.9 DISCUSSION

From the reviewed literature, based on the observations made by the Child Protection Section of UNICEF in 2013, DS has the highest registered number. Children with DS, under the education (Special Education) Regulation 2013, are defined as 'pupil with special education needs'. This means that children with DS need help or good learning aids to help them understand the lesson or draw on their interest to be involved in the lesson. Children with DS have LD in which it is proven that they need a method that can be adapted to their learning styles in the learning process. They have also proven that they can respond strongly to visual forms of information and prefer to learn actively and individually. In terms of reading ability, DS children can read just as well when the task requires a visual reading strategy (reading irregular words). Therefore, in conclusion, to enhance the learning among DS children, they require better practice in mainstream settings, from early education to further education with strong support from parents, teachers, schools, professionals, society and the structure of education. Researchers, especially in the field of technology can also provide solid support by producing good tools and apps that can support teachers and parents in the learning process. Other than that, children with DS can develop good skills in ICT and this technology can support individuals to overcome the challenges faced in learning development. Throughout their education, students must participate in targeted learning activities at developing learning skills with computer-assisted, related programs and digital technology, taking into account their respective learning needs and the practical use of these skills in everyday life. This is in line with the study conducted by Janier et al. (2015) where they find that DS children in Malaysia have many intellectual challenges whereby teachers need to find strategies so that they will progressively develop and not to assume that DS children are incapable of doing things. They could be helped using the appropriate method for their learning capabilities.

Recently, the mobility for DS learning process which offers any device, any time and any place productivity is appealing to both students and teachers. It is not the intention in this study to provide an account of the field of mobile learning; in any case, the field has already grown and diversified to the extent that doing justice to it in a brief overview is now becoming close to impossible. The learning experiences cross spatial, temporal and/or conceptual borders and involve interactions with fixed technologies as well as mobile devices. This study focuses on the primacy of technology that is liable to be perceived as learning apps in perspective on education. M-learning is seen as one of the most effective methods for students especially those with LD, to actively involve themselves in the lesson. M-learning also provides a conducive, flexible, and space-based learning environment for communicating with others, either individuals (e.g. facilitators) or components (tools – e.g. computer devices). Furthermore, it also provides a student centred learning environment that is suggested to enhance the learning development process. This is in line with Shin et al. (2011), which stated that it is necessary to combine traditional pedagogy and u-learning formats to provide analog teaching and digital interaction to users. The developers need to gain a better understanding of individual behaviours concerning u-learning, and should create effective linkages of analog pedagogy to digital interaction.

An additional advantage of mobile learning apps is that it is cheaper to produce than others. This is a very important issue as one of the main arguments against computer-based learning is the high demand, since it is always available in educational settings because of the low budget needed to produce. For this reason, this study tries to apply Android learning application for developing learning apps to DS children.

For the newly proposed and developed apps for DS students, theory or conjectures, the ideas should explain the factors in a learning environment for DS students. In this study, the HCI for child is used to understand the learning environment for a DS child because it is seen to be very helpful for designers to design a technology that is appropriate to the ability of a child. In addition, the ability of a child to use a technology tool is limited, thus researcher takes guidance from HCI for child to understand their learning environment. Meanwhile, the FDM method process is used to capture the information that needs to be identified and understood for the learning process of DS children. Therefore, for the proposed model of developing the appropriate learning apps, the UCD process and M-Learning Characteristics Framework by Martin and Ertzberger (2013) for base learning model are used. Theories have been proposed as a potential overarching framework for dealing with many issues in human development. Furthermore, Shin (2017) acknowledges that users' cognition dynamically influences and is influenced by interactivity. Interactivity and users are influencing each other and are shaped by users. Users with an interactive tendency of seeking interactive endeavours and interactive environments reinforce user attitudes and future intentions. Thus, for this research, theories are used because of the potential in furthering the integration of theory and practice, while incorporating aspects of engaging, authentic, informal learning and information captured into theoretical formulations, in order to draw on the learning apps model for DS children.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the research design of this study and the manner in which the research was conducted. This chapter will cover the research process, sampling conducted, research instrument, prototyping approach and data analysis techniques.

This study has been divided into four main phases which are; first: to understand and specify the context of users; second: to specify the user requirements and needs; third: to produce a design solution; and fourth: to evaluate the design. The method of this research design was developed according to a method adapted from the UCD process. The data collection in this study was conducted using the FDM method that comprises an analysis of relevant documentation, expert interviews, observation and studies using a questionnaire (survey) to evaluate requirements and needs as well as the good factor to enable learning for DS students. The primary objective of this study is to give good guidance or framework to the developer in producing a good learning tool for DS students in enhancing their learning performance. Various methods are used in the UCD process to understand the user and task requirements to support the process of iterative design and evaluation. Methods such as focus groups, interviews and questionnaires are often used by researchers to obtain data on the user requirements. Therefore, this study used the FDM technique to capture the user requirement since it provides the weight for each item being studied and this weighting function can provide accuracy of the data produced (Chang, Hsu & Chang, 2011).

3.2 COMBINATION OF TWO TECHNIQUES

Table 3.1 shows the summary of the processes in the two methods that were used to conduct this research. In the UCD method, this study was structured into four sections, namely understand and specify the context of use, specify the user requirements, produce design solution, and evaluate design. Under the understand and specify the context of use phase, the researcher used literature review, scoping and planning methods to identify the learning skills and learning environment for students with DS. Then, under the specify the user requirements phase, the researcher used the FDM method as a whole because it is very suitable for a small population and the weighting method adopted by this method is also ideal for studying the essential elements found in the learning environment for DS students. Furthermore, the FDM method is also recognised in the UCD method; for example, the interview and questionnaire technique is also a technique under the UCD method. However, in this study, the implementation of both techniques are in accordance with the FDM method. For the produce design solution, with the data obtained in the second phase and the M-learning Characteristic Framework by Martin and Ertzberger (2013), a model was proposed and consequently a learning app prototype was generated. Finally, under the evaluate the design phase, the researcher created a prototype testing and user acceptance test through the questionnaire method as proposed by the UCD method.

Table 3.1: The summary of the processes included in the UCD method and FDM method.

UCD Method	Fuzzy Delphi Method
Usability planning and scoping	Problem definition
Contextual Inquiry (Literature Review)	Panel / Expert selection
Interviews	Expert Interviews
User observation	Fuzzy Questionnaire
User profile / facilitators	
Sketching (low fidelity design)	
Prototyping	
User testing	
Satisfaction questionnaire	

The overview of the combination of these methods is illustrated in Figure 3.1 below.

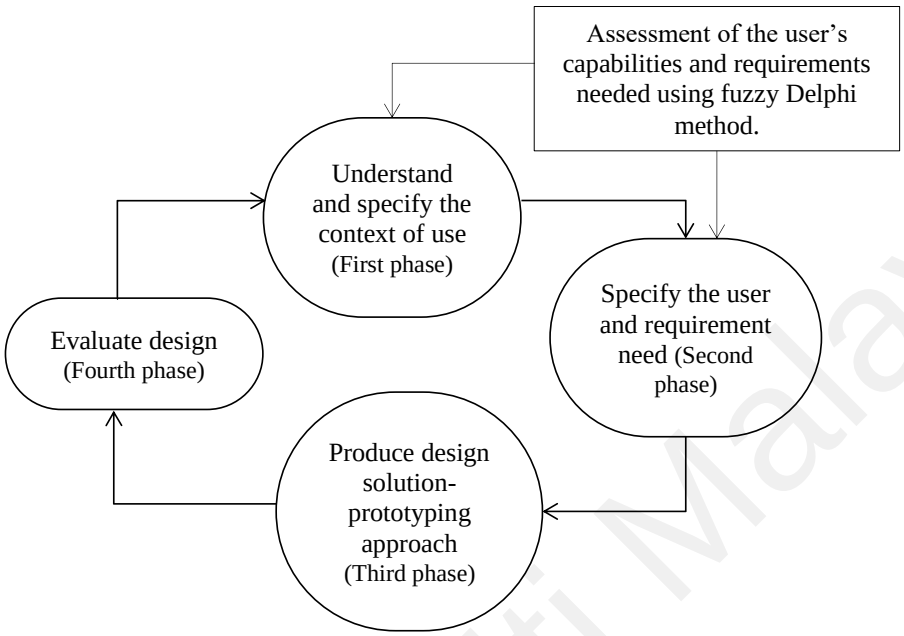


Figure 3.1: The User-centred Fuzzy Delphi Design Process.

3.2.1 Understand and specify the context of use

This stage can be briefly described as knowing the user, the environment of use, and the tasks that he or she uses the product for. It is important to understand and identify the details of this context in order to guide early design decisions, and to provide a basis for evaluation. In this study, understanding and specifying context of use is done by reviewing previous works that are related to DS students, such as their learning skills, physical and emotional attributes in learning, suitable learning methods, learning environment and technical environment (hardware, software and materials to be used). In this stage, the observation of the DS students (Malaysian students) is done to understand and identify the characteristics of users in the scope of a Malaysian setting.

3.2.2 Specify the user requirements

This stage is meant to determine the success criteria of usability of the product in terms of user tasks, specifying the functions and other requirements for the product and to determine the design guidelines and constraints. In this study, specifying the user requirements is done under the scope of a Malaysian setting by expert interviews to investigate the real potential of DS students in learning, and surveys (questionnaire) to find important factors influencing DS students to determine suitable learning skills, learning method and learning environment.

3.2.3 Produce Design Solutions

This stage can be briefly described as the incorporation of HCI knowledge (of visual design, interaction design, and usability) into design solutions. In this study, this process consists of two tasks that are done by developing the framework for the developer and developing the prototype for learning apps.

3.2.4 Evaluate Designs

This stage is conducted by data testing (evaluated against user tasks) to find the usability of designs. In this study, the evaluation is done by:

a) Prototype testing: Prototype testing was performed to examine several functionalities and services of the apps by running the apps in .EXE format. By debugging and compiling all the source codes, all types of error were recognised and eliminated.

b) User acceptance test (satisfaction questionnaire): User acceptance test was conducted to verify that the prototype functioned properly and this test involved the end users. DS students, teachers and parents were involved as the users. This is done by the teachers and parents testing the prototype on the DS students.

This was done to make sure that the objectives and the requirements of the apps were fulfilled. A questionnaire was distributed during this test for them to provide their feedback and comments.

The overall structure of this research is shown in Figure 3.2.

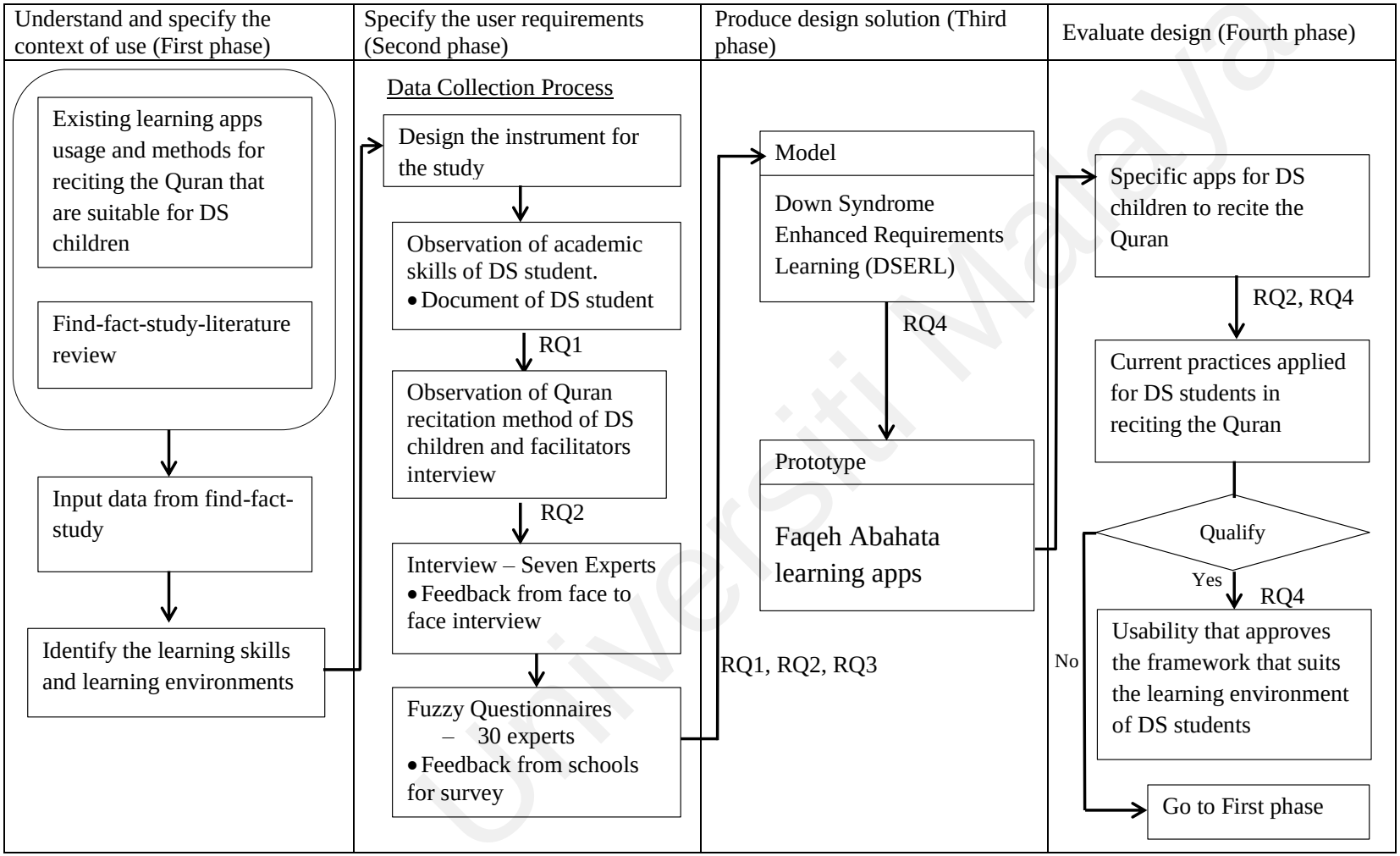


Figure 3.2: The Structure of the Study

In this study, the FDM method is used to collect data. It covers the qualitative data implement, followed by quantitative data. The collection of qualitative data was carried out first to get detailed information about the academic learning skills and learning environment for DS children from the experts (teachers, parents and specialists) perspective, since they are involved in managing the learning of DS children in school or home. Meanwhile, quantitative data was collected to identify the factors involved in the learning environment of DS children. The qualitative data was collected through interviews, whereas the collection of quantitative data was implemented using observation and surveys. Interviews, whether expert or facilitator interviews, were used in order to explore the problem and derive a detailed understanding of the requirements in learning for DS students. The literature reviews yielded little information about the phenomena of this study, so we needed to learn more from the participants through observation. Literature does not adequately address the understanding of the needs of learning for DS students and does not directly involve their learning environment in the development of the apps. That is why a fuzzy Delphi collection data was considered in order to explore this kind of situation from the perspective of experts (teachers and parents) that currently handle the process of learning. Apart from that, surveys were used to collect opinions on quantitative data to explain the experience by group experts (teachers and parents).

The data collection steps followed are illustrated in Figure 3.3.

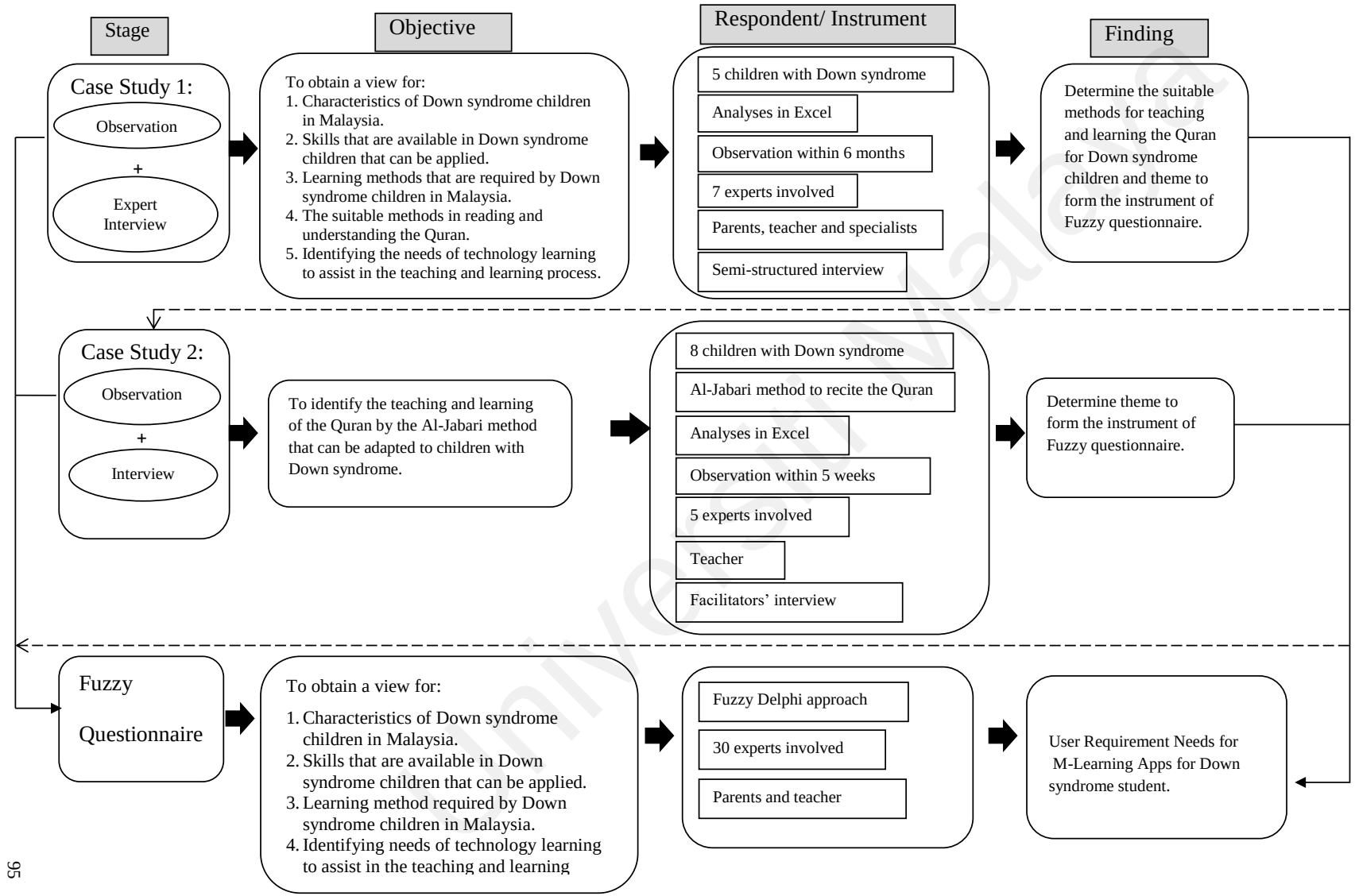


Figure 3.3: Data Collection Steps

The UCD method is used in this study as it provides an approach to user interface design that optimizes the benefit of user in terms of user friendly and machine through innovative design approaches that focus on end user needs. This approach results in a simple human–computer interface construct understandable by the user's need, and it is relevant and responsive to the learning environment. Furthermore, UCD provides guidance to improve the total human–computer performance by considering the real-world user space. Employment of UCD during product development will yield human–computer performance with more capability requiring fewer equipment operators/maintainers and the lowest total cost. Meanwhile, the FDM method was used because it is a method that has experts' opinions, in which the experts can fully express their opinion, ensure completeness and consistency of opinion. The FDM method also reduces the total number of surveys, but increases the recovery rate of questionnaires and this is suitable for analysis in a small group of participants. The strength of the FDM technique is that it is able to recognise the priorities and the elements of consensual experts, with the construction of questionnaires based on literature highlights that have been approved by the appropriate experts and data obtained solidly in only one round.

3.3 M-LEARNING TECHNOLOGIES

M-learning is defined as education or training through the use of portable wireless devices such as mobile phones, personal computers and small tablet PCs, to achieve the goal of mobility and interactivity. M-learning is a natural extension of E-learning that has the potential to improve students productivity by making knowledge and learning available anytime and anywhere, enabling learners to participate in learning activities without the traditional place and time restrictions (Hwang and Chang, 2011; Park,

2011). The benefits of M-learning stated by Sarrab, Elgamel and Aldabbas (2012) are as follows:

- Anytime access to content.
- Anywhere access to content.
- Support distance learning.
- Can enhance student-centred learning.
- Great for just-in-time training or review of content.
- It can be used more effectively for the differently.
- Support differentiation of student learning needs and personalized learning.
- Can enhance interaction between and among students and instructors.
- Reduce cultural and communication barriers between instructors and students by using communication channels that students like.

Kommentar [E1]: Hi, this sentence seems incomplete

From the discussion on M-learning in Chapter 2, the characteristic framework of M-learning by Martin and Ertzberger (2013) is correlated with the characteristics of DS. A student with DS is a student who has the strength to learn through demonstration and visual. Interactive learning activities can attract DS students to directly engage in learning activities that lead to the essential content of a lesson. In addition, DS students are also more likely to study unpretentiously without coercion or regardless of place or time. Repeated learning also helps the DS learners to learn well. Therefore, the element of engaging, authentic and informal learning shown in Table 2.7 in Section 2.6.2 in Chapter 2 is very suitable for a learning environment among those who are DS. This framework will be the basis of modelling in this study which will be discussed in Chapter 5.

3.4 DATA COLLECTION INSTRUMENTS

Data collection is a process of gathering and assessing information related to this study. The important purpose of collecting data is to obtain answers for research questions and find the appropriate design solution. The three types of instruments used in this study are as described in Figure 3.4 below.

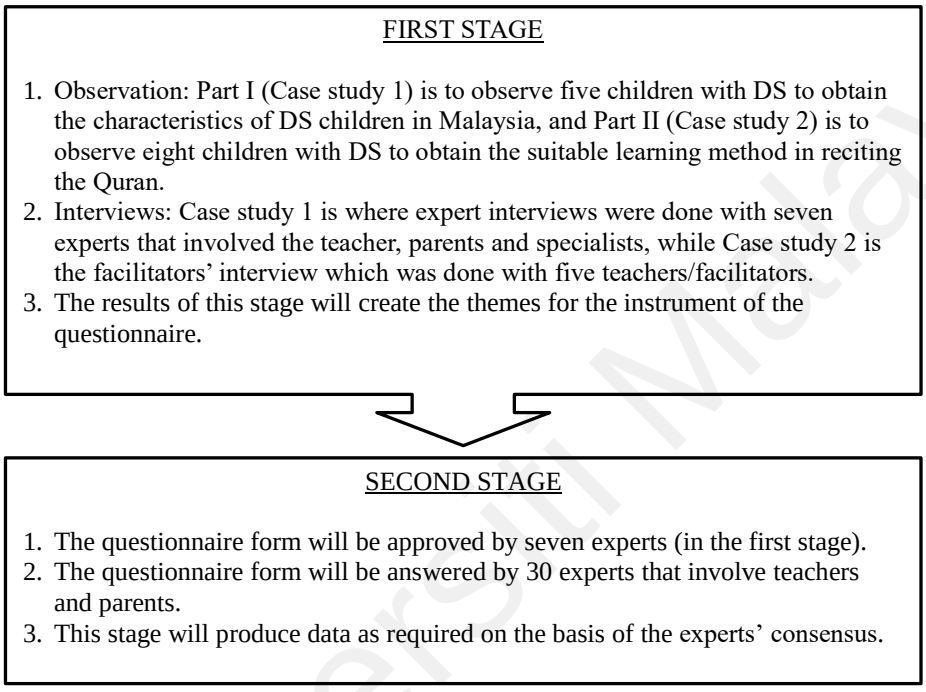


Figure 3.4: The Steps in Fuzzy Delphi Processes.

3.4.1 Observation of DS Students.

The observation in Part I is to observe the Faqeh project on DS children. This project is a programme under the Centre of Quranic Research, University of Malaya that began in 5 February 2012. It is an effort carried out in groups in order to learn, know, and understand the Quran for children with special needs. This method is a self-therapy for children with disabilities or special needs to learn the Quran just like other normal children. This Faqeh project involves mutual understanding between the trainers (instructors/ facilitators) and children with special needs as the trainers need to give

proper guidance by using the right teaching aids that are suitable for their students. Students with special needs are not the same as normal students, thus trainers need to study the suitability of a teaching aid for these special students. This coincides with the statement of Grieco et al. (2015) who mentioned that the existing modern classrooms do not provide an adequate learning environment for students with special needs. Iarocci, Virji-Babul and Reebye (2006) in their study on a programme named The Learn at Play Programme (Lapp), also stated that such a programme may be beneficial and may serve to provide long-lasting constructive outcomes for children with DS, as well as for their families. Melam et al. (2014) also stated that the developing skills in people with DS requires a lot of repetition over an extended period. Therefore, some approaches that not only provide regular practice but also incorporate variety such as playing picture word games, using a phonics software program, and working with a tutor must be adopted.

The purpose of this observation was to evaluate the acceptability of the Faqeh project introduced to the DS children. The case study in this research was conducted as follows: (1) this study involved homogeneous participants; (2) the target skills were to get to know and understand the characters and phrases in the Quran; (3) the programme was carried out within six and a half months; (4) the training was monitored in a house (bungalow house building); and (5) the teachers (instructors) were given a conducive training beforehand.

The observation in Part II was done to observe recitation of the Al-Quran using the Abahata (Al-Jabari) technique. This technique requires learning with music or melody that is their basic learning in the 30 hours of conversational meetings. This technique starts with an induced set that is Solsimasi (*Nazham*), *Selawat Badar*, The Book of Qur'an song and Bridge of Memory song (Irnawati et al., 2012). The syllabus includes

four books that are Book 1 to Book 4. The learning process starts with a prayer and continues with singing the *Selawat Badar* and The book of Qur'an song. Then, within the same melodies, the facilitators introduce the Bridge of Memory, that is the list of *Hijaiyah* letters. Besides that, this technique also includes writing the *Hijaiyah* letter in each of their books. The students are also introduced to the right pronunciation of the *Hijaiyah* letters and its words with the correct nouns in Arabic pronunciation. This encourages students to learn to recite the Quran and learn to write the Quran's letters at the same time.

The case study in this research was conducted with eight DS children in the range of thirteen to twenty one years old. This study involved participants with the following criteria: (1) the students are DS children; (2) the students were behaviourally inside; (3) the students uphold Islam as their religion. The program for students with DS went on for five weeks in the bungalow of Faqeh and with three meetings conducted a week; each meeting lasted three hours. Whenever the first half-hour meeting was conducted, students and teachers started learning by reading *ruqyah* the zikr en masse, after which, the students were divided into groups that had been assigned to the learning session. In the last half hour, all the students and teachers regrouped to strengthen the bridge of memory song.

Kommentar [E2]: The sentence/term is not clear.

3.4.2 Semi-Structured Interview

The expert interview was done with seven experts that involved the teacher, parents and specialist. The seven experts included experts with above five years of experience with DS children. Table 3.2 below describes the information of the experts.

Table 3.2: Detailed Information of the Experts.

Participants	Sex	Age	Experience or Learning Experience with DS Children
Expert 1	Male	54	The President of Down Syndrome Association of Malaysia (Persatuan Syndrome Down Malaysia-PSDM) and parent of an 11 year old child with DS.
Expert 2	Female	44	10 years experience with the Teacher Special Education under Special Education Integration Programme (Program Pendidikan Khas Integrasi-PPKI) and Assistant Director of Special Education, Curriculum Development Centre, Ministry of Education (MOE) and now Admin PPKI - Learning Disabilities.
Expert 3	Male	51	20 years of experience with learning disabilities group of students and 16 years of experience teaching DS students. Now, he is the top coach for Special Education under the MOE.
Expert 4	Female	53	13 years experience with DS children, parent of a 13 year old child with DS and was a teacher at the Department of Special Education, Ministry of Education, Putrajaya, for 6 years and now a Teacher of Special Education / students' therapist in PSDM.
Expert 5	Female	42	11 years experience with DS children and parent of an 11 year old child with DS and 10 years as a member (parent) at PSDM.
Expert 6	Female	46	Associate Professor in Kulliyyah of Information and Communication Technology, IIUM Gombak Campus, with 5 years of experience in building apps or learning material for Learning Disabilities through research work
Expert 7	Female	32	Therapist in School Based Occupational Therapist, Ministry of Education. 5 years of experience working with persons affected by learning disabilities.

In this research, the experts' interview was chosen in the early stage because this study has to:

- Identify the characteristics of students with DS in Malaysia.
- Identify a method of learning for DS students and its strategy of learning.
- Identifying the needs of technology learning to assist in the teaching and learning process.

Meanwhile, the facilitators' interview was done with five teachers or facilitators after they finished teaching the Abahata (Al-Jabari) method to the DS students in five weeks. The facilitators are seen as a persona that represents an aggregate of target users who share common behavioural characteristics (i.e., a hypothetical archetype of real users) (Miaskiewicz & Kozar, 2011). In this study, the facilitators' interview was documented because they provided more detailed information about the success of the Abahata (Al-Jabari) programme for the DS students.

3.4.3 Surveys (Fuzzy Questionnaires)

Questionnaire survey was the main research tool in this study. The study interviewed seven experts, with an experience of five years and above, to identify methods and strategy of learning for students with DS. Based on the results of interviews with the experts, a set of questionnaire was designed with reference to the related literatures and interviews with experts, so this survey used items that was approved by the experts. The aim of this survey is to determine all the factors that influence the requirements of learning among DS children/students.

Respondents were asked to respond to all the statements using the triangular fuzzy linguistics scale ranging from Very strongly agree (7); Strongly agree (6); Agree (5); Medium agree/ Not sure (4); Disagree (3); Strongly disagree (2); and Very strongly disagree (1). The seven triangular fuzzy linguistics scales were used to understand the extent in which the respondents agree or disagree with that statement related to the learning requirements of DS children. To be more precise, the surveys were conducted to discover the factors that influence the DS children/students by teachers or parents choosing the right requirements in a learning environment with DS children.

The objective of this survey is to discover problems faced by the developer in finding the solid requirements in learning for DS children. The processes involved in this questionnaire are discussed in sub-sections 3.4.3.1 until 3.4.3.3.

3.4.3.1 Population and Sampling

The unit of analysis was individual teachers or parents with a background of having experience with DS children, with a total of 30 respondents from schools and centres around Selangor and Kuala Lumpur, Malaysia. According to Skulmoski, Hartman and Krahn (2007), the sample size used is based on Adler and Zinglio (1996), who mentioned that, in Delphi method, the number of experts with full experience is between 10 to 15 of the experts. Meanwhile, Jones and Twiss (1978) recommended that the sample size for population is between 10 to 50 of the experts. Hence, a representative sample size of 30 experts was deemed reasonable to give a satisfactory response rate. In this study, the population of the respondents is in the field of teaching and learning for children with DS. As the field of teaching and learning includes various parties, those who deal directly with DS students with DS were selected, including teachers, parents and therapists.

3.4.3.2 Instrument Development

The questionnaire consists of two parts. Part 1 is related to personal details, while Part 2 is the seven linguistics points agree/disagree scale option. A seven point linguistics scale was used and a higher point indicated a higher importance (refer to Table 2.10 in Chapter 2).

Part 1: Demographic details, such as Faculty/School/Centre/Association, Department/Division, Occupation, Area of expertise and Experience with DS community. For this part, respondents simply ticked in the boxes that were provided.

Part 2: Requirements in learning details were divided into three sections. The first section was about the strengths of DS students in learning sessions and the second section was about the methods of learning while the last section was about the structure of learning technology for DS students. The details of the question is described in Table 3.3 below.

Table 3.3: The Details of Questionnaire

Section	**Item on the questionnaire**		**Remarks**
A	5 questions		Demographic details
B	1.1	1-3	Identify the characteristics of students with DS
	1.2	1-5	
	1.3	1-5	
	1.4	1-4	
	1.5	1-3	
C	2.1	1-7	Identify method of learning for DS students and its strategy of learning
	2.2	1-4	
	2.3	1-6	
	2.4	1-10	
D	3.1	1-4	Identifying needs of technology learning to assist in the teaching and learning process
	3.2	1-6	
	3.3	1-5	
	3.4	1-4	
	3.5	1-6	

3.4.3.3 Data Collection

Data was collected using hardcopy questionnaires that were distributed to four schools or centres that operate in Selangor and Kuala Lumpur, where the subjects were teachers of special education, parents of DS students and therapists of the department of special education under the Malaysian government. They were contacted and informed of the survey intention. The questionnaires were distributed after permission was obtained. Finally, a total of 50 questionnaires were distributed, and more than 36 were returned as valid. A valid response rate was 72%. After a data cleaning process by considering the completed answers, only 30 sets were used for analysis.

3.5 VALIDITY AND RELIABILITY OF QUESTIONNAIRE ITEMS

Validity testing is necessary to ensure the legality of the items that are built can help provide answers to the research questions. An item or instrument has a high validity value if the items built in the questionnaire can measure what should be measured (Edimansyah, Rusli, Naing, & Mazalisah, 2006). In the opinion of others, Piaw (2006) argued that validity is used to measure the accuracy of a measurement used in the study. It is aimed to determine whether the measures contain all the features or ideas that should be present in the concept which is measured. The findings of the research would be meaningless if the measuring device used cannot measure what should be measured.

The research instruments need to be verified in terms of validity and reliability. The survey's item questions have to be carefully examined to make sure that this survey is acceptable especially on their items. In this study, the survey's protocol was acceptable with the experts. A reliability and validity test of the instrument was conducted using Cronbach's alpha method.

3.5.1 Measurement of Alpha Cronbach

Cronbach's alpha was developed by Lee Cronbach in 1951, as a way to measure scale reliability, or internal consistency instrument, of a set of scale or test items. The term of reliability is considered as how well a test consistently measures what is supposed to be measured. For example, a set of questionnaire is a survey of satisfaction from an employees' job. High reliability for the test would mean consistently measuring job satisfaction. Low reliability would mean measuring something else, or possibly nothing at all.

Reliability tests, like Cronbach's alpha, are most commonly used to show if questionnaires with multiple Likert scale questions are reliable. These questions are designed to measure latent variables. A latent variable is a hidden or unobservable variable, like a person's conscientiousness, neurosis or openness. These variables are notoriously difficult to actually measure so that Cronbach's alpha will show that the items in the questionnaire designed is accurately measuring the latent variable that the study is focused or interested in. The formula for Cronbach's alpha is:

$$\alpha = \frac{N.\hat{c}}{\bar{v}+(N-1).\hat{c}}$$

Where:

N = the number of items

$\hat{c}$ = average covariance between item-pairs

$\bar{v}$ = average variance

The rule of thumb for interpreting Cronbach's alpha for dichotomous questions (i.e. questions with two possible answers) or Likert scale questions is as shown in Table 3.4 below:

Table 3.4: The measurement of internal consistency for Cronbach's alpha

Cronbach's Alpha	Internal Consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Testing the reliability of the questionnaire is also required to view the relevance and understanding of the respondents to the items in the questionnaire. Terms of the questionnaire are based on the Cronbach's alpha value obtained. This has been debated by Tavakol and Dennick (2011) which states that the value of Cronbach's Alpha acceptable minimum is 0.7. However, McKinley, Manku-Scott, Hastings, French and Baker (1997) opined that the Cronbach's alpha reliability can be classified into three classes, namely if the alpha value is worth 0.60, it shows that the reliability index is the minimum acceptable. Bland and Altman (1997) also agreed with the opinion that Cronbach's alpha values should be more than 60% for the acceptability of the item.

3.6 SUMMARY

This chapter discussed the capturing of end-user requirements for the study that provides an approach to design solution. In conclusion, this study uses a User-centred Fuzzy Delphi design process which is a combination of UCD process and FDM method. During this process, the researcher conducted two case studies to obtain the user requirements that will cover research objective one (RO1) and research objective two (RO2). This chapter also covers topics such as research setting, research sample, research instruments, method of data collections and data analysis techniques. The validity and reliability of the instruments are also covered in this chapter. Details of the data collection process for observations, interviews and surveys are discussed in Chapter 4. It also presents the data analysis and findings from the data collection.

CHAPTER 4: DATA COLLECTION AND ANALYSIS

4.1 INTRODUCTION

This chapter describes in detail how the data collection and data analysis were carried out. It explains how the FDM is applied in this study and how the data analysis is carried out for the data collection.

Data collection consists of three phases: i) Case study 1 that uses observation and experts' interview; ii) Case study 2 that uses observation and facilitators' interview; and iii) Fuzzy questionnaires for the survey process. Case study 1 is meant to explore the characteristics of DS children in a Malaysian environment. From the literature review, most of the information are about DS children from overseas and not enough study information of DS children from Asian countries. Therefore, the observation on DS children in Malaysia was conducted to find out the requirements related to their learning environment. Hence, the expert's interview was conducted to explore the problem, and derive a detailed understanding of DS children especially in terms of their learning needs and learning environment. Then, the second observation was conducted to observe if the Abahata (Al-Jabari) method of reciting the Quran can be adapted with DS children, while the facilitators' interview was conducted to collect the teachers' opinion as facilitators of the program. Furthermore, the Fuzzy questionnaire was conducted to get an expert in setting the priorities of the elements. This analysis is capable of analysing an agreement that specializes in only one round so that an expert consensus can been reached.

This chapter aims to answer the following research questions:

Case study 1

RQ1: What is the learning environment for DS students that is appropriate with their style of learning in order to cater to their academic skills?

Based on this research question, the observation was done in six months to note the academic skills of DS students. Meanwhile, the research respondents (experts) were asked about the characteristics of students with DS, the learning method used for DS students and the strategy of learning as well as the needs of technology learning to assist in the teaching and learning process. The research question seeks to derive a detailed understanding of the learning needs and learning environment among DS students (refer to APPENDIX A for the Interview Questions form).

Case study 2

RQ2: What is the suitable method for learning and reciting the Quran for children with DS?

Based on the literature review on the methods of reciting Al-Quran in Malaysia, the Abahata (Al-Jabari) technique of reciting the Quran is the best way for DS students to recite the Quran. Therefore, the second observation conducted in five weeks was done to know if DS students can adapt to this technique. Meanwhile, the facilitators' interview was conducted to get the teachers' opinion as facilitators to the DS students during this program.

Fuzzy Questionnaire

RQ3: What are the factors involved in formulating the user requirement model which is appropriate with the DS students' criteria and fulfils their learning requirements and needs?

Based on this research question, a survey was conducted involving a group of experts (teachers and parents) to find the actual learning needs and learning environment for DS students so that a suitable learning tool can be designed. The surveys are related to the finding of appropriate elements that can be used to build an affordable user requirement model and subsequently produce the M-learning app, which meet the learning requirements of DS students.

Table 4.1: Data Collection Phases

Phase	Instruments	Respondents
Case Study 1	Observation in six months	5 children with DS.
	Expert's Interview	7 experts that involve parents, teachers and specialists.
Case Study 2	Observation in five weeks	8 students with DS.
	Facilitator's Interview	5 experts that involve the teachers as facilitators.
Fuzzy Questionnaire	Surveys	30 experts that involve parents and teachers from 4 schools and centres.

Table 4.1 shows the phases involved in the process of data collection in this study, the instruments used and the respondents for each phase.

4.2 CASE STUDY 1

4.2.1 Observation Part 1

4.2.1.1 Scenario

Students with DS were introduced to the learning of Al-Quran through the Faqeh project. This is a programme under the Centre of Quranic Research, University of Malaya that began on 5 February 2012. It is an effort carried out in groups in order to learn, know, and understand the Quran for children with special needs. This method is self-therapy for children with disabilities or special needs to learn the Quran just like other normal children. This Faqeh project involves mutual understanding between trainers (instructors/ facilitators) and the children with special needs as the trainers need to give proper guidance by using the right teaching aids that are suitable for their students. Students with special needs are not the same as normal students, thus trainers need to study the suitability of a teaching aid for these special students. Furthermore, some approaches not only provide regular practice but also incorporate a variety of activities such as playing picture word games, using a phonics software program, and working with a tutor.

The purpose of this observation was to evaluate the acceptability of the Faqeh project introduced to the DS children and observe the learning skill which is practiced for DS students. The case study in this research was conducted as follows: (1) this study involved homogeneous participants; (2) the target skills are to know and understand the characters and phrases in the Quran; (3) the programme was carried out within two to four months; (4) the training was monitored in a house (bungalow house building); and (5) the teachers (instructors) were given a conducive training beforehand.

4.2.1.2 Materials and Methods

Participants

Five DS children between five to eleven years old took part in this study. The selection of these students was based on the following inclusion criteria: (1) the students were DS children; (2) the students were able to understand behaviours; and (3) the students were Muslim. All five students were between five to eleven years old. Below is the description of each student:

Badrul

Badrul was 7 years and 4 months old when he underwent the Faqeh project. He was one of the children with DS. Badrul received his early education and schooling at SKTM 2/Kiwanis Down syndrome Foundation. Badrul's advantage is his visual skills and good behaviour, but his physical ability was limited as the coordination between his eyes and his movements was weak.

Darwish

Darwish was 11 years old when he underwent the Faqeh project. He was one of the children with DS. Darwish received his early education and schooling at CADs Enhancement Centre, Jalan Duta, Kuala Lumpur. Darwish's advantage was being able to memorise/remember someone's name and recognise things easily. He was friendly, sociable, and very loving.

Erman

Erman was 6 years old. He was one of the children with DS. Erman was a very good and gentle student, and good in following instructions. He was also very interested in flowers.

Chahel

Chahel was 6 years and 1 month old when he underwent the Faqeh project. He was one of the children with DS. Chahel received his early education and schooling at Sekolah Kebangsaan Saujana Utama/Kiwanis P7. The advantage of Chahel was that he had good understanding and was able to communicate well with other people, but still relied on makaton sign language. Chahel really enjoyed learning, thus resulting in his abilities to recognise and count numbers from 1 to 10. Chahel loved to make friends and was very loving.

Ahmad

Ahmad was the youngest of 9 siblings. He was only 5 years old. He was one of the children with DS. He was a very active child, cheerful and loved to make friends. Even though he was still very young, he was able to communicate with others very well. He was also very fond of video materials and teaching aids that showed animations or anything similar.

All of these students came to the venue according to the sessions suitable with the parents' time. Every week, the Faqeh instructors will teach according to the set of skills scheduled. In general, the participants were very interested to learn the Quran. The most significant features described were:

- How do these children learn and pronounce the ***hijaiyah*** word?
- How do they read the sentence in the Quran?
- What type of Multimedia environment learning do they like most?
- How is the communication between trainers and the participants?
- What is the emotional reaction of the participants throughout the learning process?

Trainers

Trainers were appointed among those who have a wide knowledge particularly in the Quranic field. They were required to attend two theory classes to make sure they understood the way this programme was going to be held. Besides that, the trainers were also required to go through eight practical sessions in order to strengthen their roles as trainers i.e., to help and monitor the students.

Modules in the Faqeh Pilot Project

Learning is a process to acquire skills and knowledge and to form attitudes. Motor skills learning involves processes in the sensory neurons and motor processes. This learning aims to obtain information, use the information, learn something, and do something. Fine and gross motor skills development of a child mostly depend on the development of the brain, balance, and improvement of the body's coordination. However, for special education children, it differs from normal children in terms of their mental and sensory capabilities, neural characteristics, muscular, physical, social or emotional behaviours, communicative abilities, and various other aspects. Therefore, the Faqeh project could help these special children to learn and understand the Quran in a way that they can cope.

The Faqeh project included a number of phases which are as follows: 1. Student Self Introduction/Diagnostic Test; 2. Proficiency Test; 3. Hearing Test; 4. Learning and Teaching Session; and 5. Memorising. In the first phase, the students' details were recorded in a form. Their parents were asked to fill in the details about themselves and their child. The interview session with the trainers and parents was conducted before the session started to give an understanding to the parents regarding this programme and to

allow the trainers to get to know the student. Apart from that, the trainer can also understand the needs and wants of the student and their parents. Next, the trainers conducted a diagnostics test using a specific form. The students were asked to mark (√) for items that they could identify and (X) for items that they had yet to. If the students were unable to speak due to difficulties such as mute, autism, Down syndrome or stutter, the students only had to point it out or code it. After the test, the trainers were required to conclude by giving marks and the test will be repeated or continued the following week for identification if the proficiency test could not be completed in one session.

In the second phase, the Proficiency Test which was conducted the following week whereby the trainers were to identify the students' credibility and skills so that the trainers can develop and utilise the students' skills to understand and learn the Quran more effectively. In the early stages, the trainers showed cue cards with letters joined one after another and observed the students' response based on their uttering (oral), pointing (matching), and hand signals. After that, the trainers made a short conclusion in the designated form. In the third phase, the trainers conducted a hearing test for the students to detect their listening abilities and consequently to plan strategies to help the students to listen better. Quranic verses were played in the classroom to familiarise them with the verses; listening to Allah's words was for their souls to be calmer. This was also meant to test their focusing ability and to further improve the students' focusing ability. IT-based learning aids such as PowerPoint, iPhones, iPads, CDs, digital Quran, and recordings of their own voices would be a tremendous help to the students to enhance their abilities in this skill. This test was repeated again and again, and the trainers would take note about their achievements (repetition frequency using a tally system) until the students showed a positive development. Besides that, a number of

reinforcement activities were also done, such as a more creative and fun way of recognising letters (learn as you play) and use of IT (Game-IT).

The fourth phase was the Learning and Teaching Session where the trainers divided the Arabic letters into a few groups and introduced them to the students one by one. Activities that were done included an identifying game, matching the cue cards, sketching in the air, coding, pointing at the correct letters, writing, colouring, forming the letters using buttons or modelling clay, pasting, repeated pronunciations, letters bowling, and forming shapes. Trainers took note of the students' performance in a designated form (performance indicator form). This session was repeated multiple times as a reinforcement activity for the students. Next was the final phase, the memorising activity, which began with making the student listen to a verse and asking them respond. This step was repeated with the ***mashaf*** (Quranic manuscript) in front of them. After that, the students were required to repeat the verse twenty times with the ***mashaf*** covered. It was tallied and remarks were given systematically by the trainers. Trainers asked for assistance or cooperation from the parents to frequently revise (***muraja'ah***) the memorised verses, for example listening to the verses at home or in the car. Trainers made a conclusion on the students' performance form. Learning aids such as digital Quran, iPad, and iPhone were still used provided the revision was still in ***talaqi*** and ***masafahan***.

Through the course of discussions of the phases above, it is clear that the programme was conducted according to skills with a specific target to be achieved. Skill is an action, task or a defined reaction pattern with a developed ability and willingness. This is a general character which depends on factors like genetics, environment, and learning. According to Lewthwaite and Wulf (2010), motor skill is the ability to produce a

behavioural pattern related to a specific environment. In this Faqeh project, the methods used were of a conventional style, touching and listening, touching and reading, and video visualisation. There were many skills emphasised in this training including listening, mentioning, recognising (identifying), organising, repeating (imitating/emulating), and reading. For example, the skill of mentioning some words by following the recitation of the *qari* (one reading the Quran). Meanwhile, in terms of recognising skills, it was evident when the students managed to continue the verses recited by the trainers.

Procedure/Tools

Individuals with DS possess many capabilities that can contribute in developing this country. The intelligence level of children with DS, compared to normal children, is severely not at par. The level can be enhanced but to a limited extent when they are in their juvenile ages. In their post-juvenile ages, however, the growth of their intelligence level will usually not show any development. But, these special children are able to survive like normal people thanks to productive, systematic, and strategic teaching and learning (Fidler, Hepburn & Rogers, 2006). Therefore, the Faqeh project attempts to apply certain techniques to help these special students to acquire skills in learning.

Students form a learning style since early childhood and then use that learning style to adapt to their lessons. Thus, a learning style practised by normal individuals is not different from these special students. The style of learning may be influenced by specific factors. A model in understanding the style of learning has been introduced by Felder and Silverman (1988). This model is divided into four categories, namely Active and Reflective, Concrete and Intuitive, Visual and Verbal, and Organised and Global. Other than that, according to Wang and Chugh (2014), students tend to focus on facts, data,

and algorithms. Some students respond strongly to visual forms of information, and many others prefer to learn actively and individually.

Stated below are the skills monitored in this Faqeh project, guided by the consultant of the project, Faqeh Intellect Academy, in which one of the members has an experience of special needs and Quran education for more than 20 years under his belt.

Listening skill

Listening is a basic and vital skill in the process of communication, and it is an early skill acquired by children. Based on the literature review, it is proven that even though children with DS have problems in hearing, with the aid of applications such as Frequency Modulated (FM) sound field amplification; they will be able to acquire listening skills. Therefore, in other words, this proves that children with DS can hear and are capable of having good listening skills.

Figure 4.1: The use of Digital Pen and iPad by Students with DS.

In the Faqeh project, listening skills were formed by listening to the recitation of ***Surah al-Fatihah*** a number of times, played on a mini laptop, mobile phone, Quran digital pen, and tab, as shown in Figure 4.1. This listening skill activity was conducted from time to time until the students were able to read the verse on their own. The aim of this process was for the students to be able to improve themselves in the process of listening and be able to read the words well.

Reading and Mentioning Skills

Reading and mentioning skills can be a process of speech and language therapy reassessment and it is used to facilitate interpersonal communication and language for thinking. According to the literature review, this proves that children with DS experience slow spelling development at an early stage, but have a steady and significant annual progress in terms of learning to read over a two-year period.

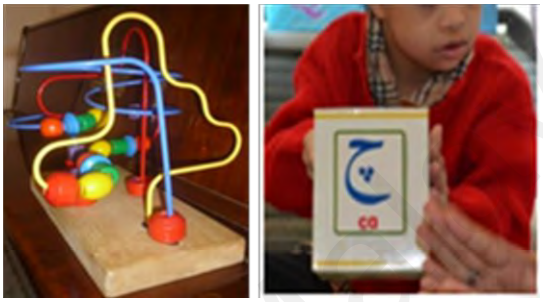


Figure 4.2: Learning Tools used by Students with DS.

In this Faqeh project, this recognising skill was performed after the students were able to recognise letters. Figure 4.2 shows the tools used in the recognising process. The students were required to match the shape of letters with their respective holes. This tool allowed the students to recognise letters while playing. Letter-recognising activities can also be done using alphabet blocks, bowling game, and flash cards. Mentioning and reading skills were also practised in the Faqeh project. The mentioning skill was performed using flash cards and a mini stroller. The mini stroller allowed the students to play while saying the words i.e., when they moved the toy, the students were asked or trained by the trainers to speak out the letters. Using this method, they learned faster and it did not bore them. The use of flash cards also helped the students as they were asked to pronounce out loud the letters shown on the cards after the trainers had said the letters.

Recognising, *Imitation* (*repetition*), *and Arranging* (*simple movement*) *Skills*

The skills mentioned in this subtopic are the easiest basic skills for children with DS to grasp because they perform relatively well in skills involving visual demonstration. Based on the literature review, individuals with DS tend to exhibit a performance advantage under visual instruction.

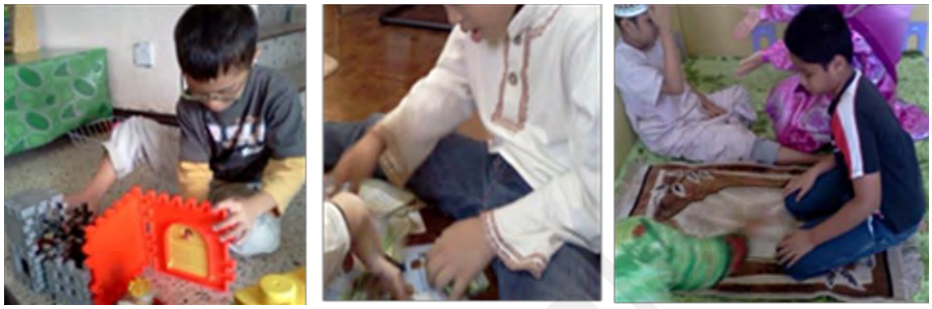


Figure 4.3: Methods used in the Teaching and Learning Process.

In the Faqeh project, the students' creativity in recognising letters was displayed through their arranging skills with the help of flash cards. Students were also taught shapes and colours using teaching aids such as the building blocks shown in Figure 4.3. Apart from this, the Faqeh project also taught imitation skills through the practice of *solat* (prayer) (Figure 4.3). The students were taught the proper steps of ablution through the movements shown by the trainers or through posters with pictures showing the steps in performing ablution.

4.2.1.3 Results: Findings from Observation Part 1

In this study, the Faqeh project involved five students: Badrul, Erman, Darwish, Chahel, and Ahmad. Their performance in various skills were analysed and are presented in this section. The skills analysed were listening, memorising, recognising, writing, arranging, imitation, and mentioning. These sets of skills are the branches of the skills discussed earlier. This analysis used a four-point scale from 1 (poor) to 4 (good) as shown in Table 4.2, which is to analyse the students' performances and skills.

Table 4.2: The four-point scale

Scale	4	3	2	1
Meaning	Good	Satisfactory (good)	Fairly Poor	Poor

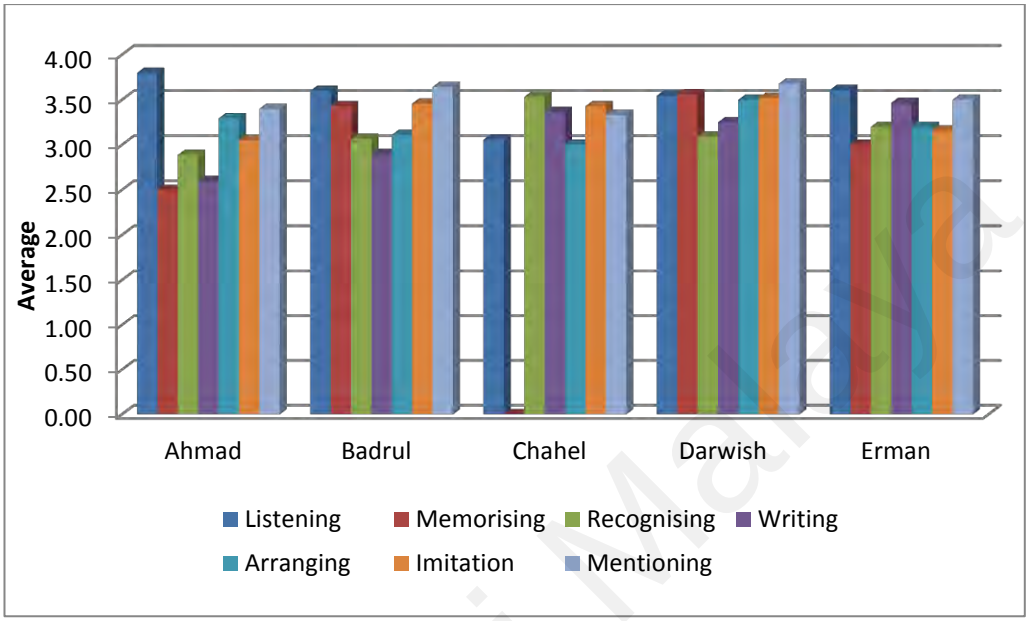


Figure 4.4: Analysis on Students with DS in Learning Skills.

Figure 4.4 shows that the students' performances in different skills varied from each other. After 27 weeks of observation, Ahmad was found to be having the best skill in listening, mentioning, arranging, and imitation skills with the average scores of 3.80, 3.40, 3.29 and 3.05, respectively. Badrul showed a good mentioning skill (3.64) and listening skill (3.60), along with imitation (3.46), memorising (3.43) and arranging skills (3.11). Chahel had average scores of 3.53 in recognising, 3.43 in imitation, 3.36 in writing and 3.33 in mentioning. Darwish managed to get 3.68 in mentioning, 3.56 in memorising, 3.55 in listening, 3.52 in imitation and 3.50 in arranging. The final student was Erman who had good scores in listening, mentioning, and writing skills, with average scores of 3.61, 3.50, and 3.47, respectively. Erman also performed well in

arranging and recognising skills, scoring 3.20 for both skills. Table 4.3 shows the mean and standard deviation of each skill.

Table 4.3: Student Skills (N = 5 for 27 week observation)

Skills	Mean	Standard deviation
Listening	3.52	0.28
Memorising	2.50	1.46
Recognising	3.16	0.24
Writing	3.12	0.36
Arranging	3.22	0.19
Imitation	3.32	0.21
Mentioning	3.51	0.15

Table 4.4: Four Best Skills Possessed by All Students and the Number of Students scoring in Each Skill.

Name	Listening (M)	Memorising (M)	Recognising (M)	Writing (M)	Arranging (M)	Imitation (M)	Mentioning (M)	The Best Skill
Ahmad	3.80				3.29	3.05	3.40	Listening
Badrul	3.60	3.43				3.46	3.64	Mentioning
Chahel			3.53	3.36		3.43	3.33	Recognising
Darwish	3.55	3.56				3.52	3.68	Mentioning
Erman	3.61		3.20	3.47			3.50	Listening
Number of Students	4	2	2	2	1	4	5	

From the analysis in Table 4.3 and Table 4.4, after twenty seven weeks of observation, Table 4.3 presents the mean (M) and standard deviation (SD) of the performances of listening, memorising, recognising, writing, arranging, imitation, and mentioning skills displayed by the respondents. From the results in Table 4.3, 'Listening skill' has a high mean score of 3.52 and it has the lowest score of standard deviation, which is 0.28. The second is the 'Mentioning skill' with a mean score of 3.51 and standard deviation score of 0.15. This shows that listening and mentioning were the skills most exemplified by all of the students. Meanwhile, memorising skill has a lowest mean score of 2.50. This shows that DS students have a weakness in memory skill.

In addition, Table 4.4 shows four skills that have been identified from the analysis as the best skills possessed by each student, and the number of students in each skill. Based on the analysis in Table 4.4, it appears that there are three skills that are compatible with all students, namely mentioning, listening and imitation, with above 80% of the students respectively. Meanwhile, 40% of the students performed well in memorising, recognising and writing. This shows that these skills can be further improved in DS students. Furthermore, Table 4.5 shows the analysis of correlation among skill study variables. From this analysis, it appears that listening skill was strongly and positively correlated with memorising ($r = 0.806$, $p = 0.001$) and arranging ($r = 0.564$, $p = 0.001$). Meanwhile, mentioning skill was positively correlated with memorising ($r = 0.847$, $p = 0.001$), arranging ($r = 0.562$, $p = 0.001$) and imitation ($r = 0.523$, $p = 0.001$).

Table 4.5: Correlations Among Skill Study Variables

Skills	Listening	Memorising	Recognising	Writing	Arranging	Imitation	Mentioning
Listening		0.806	-0.960	-0.606	0.564	-0.544	0.390
Memorising			-0.772	-0.240	0.665	-0.008	0.847
Recognising				0.751	-0.618	0.410	-0.424
Writing					-0.142	0.362	0.017
Arranging						0.004	0.562
Imitation							0.523
Mentioning							

Memorising skill is one skill that is needed for strength in learning especially to recite the Quran, but from this analysis, memorising skill is not the best skill among DS students. Therefore, based on Table 4.4 and Table 4.5, it can be concluded that the memorising skill can be polished with three skills which are the listening, recognising and mentioning skills. Meanwhile, the listening skill can be polished with the recognising skill, while the recognising skill can be polished with the writing skill, and the mentioning skill can be polished with the imitation skill. Besides that, the arranging skill that has only one student who performed well (see Table 4.4), can be polished with

the recognising skill and mentioning skill. Figure 4.5 shows the illustration of these connections.

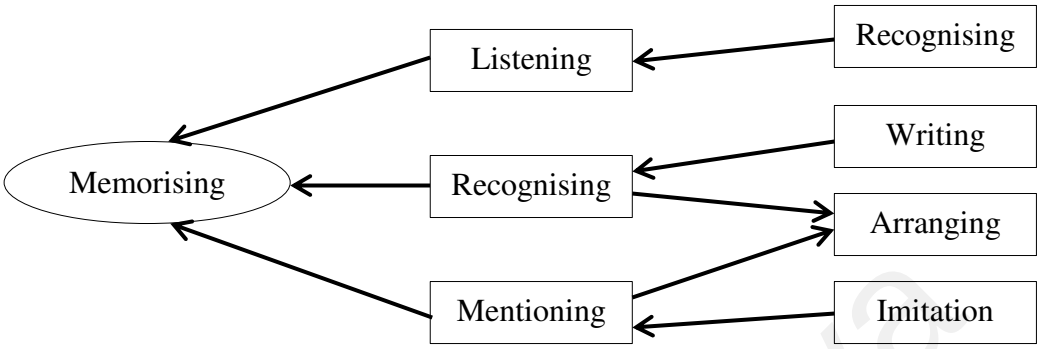


Figure 4.5: The illustration of Skills Polishing.

From the summary of the data analysis above, listening, mentioning and imitation were rarely the skills possessed by all of the students. However, listening and mentioning skills are strongly and positively correlated with memorising, arranging and imitation. Based on this result, it is proven that listening, mentioning, and simple movement skills (such as arranging and imitation) can be taught to the students despite their aforementioned learning disabilities. This result is supported by the research done by Grieco et al. (2015), de Menezes et al. (2015), Melam et al. (2014), Park et al. (2012), and Burgoyne et al. (2012). It is also in line with the results obtained by Levis et al. (2012) and Cebula et al. (2010). The teachers had to be more creative and persuasive. These children with DS seemed to be very friendly and they liked to make friends, especially with children of the same age.

In addition, from the illustration shown in Figure 4.5, it can be seen that memory skill of DS students can be polished with other skills. Therefore, researchers should take note in this regard to enable the software or app that will be developed is able to stimulate memorising skills in a better direction. Apart from that, similar to normal children, they

also love to play. These factors must be considered by the teachers during the teaching and learning process. The teaching aids used were simple and easy for the students to use. For example, the teachers could use those teaching aids as toys because they seemed to be more interested in teaching aids that involved physical touch. The use of touchscreen through mobile phones or computers helped a lot in this research because it has been studied that children with DS are more keen and happy to use such technology. Therefore, it is recommended that the Faqeh project can be continued on a daily basis instead of a weekly basis because useful knowledge in various aspects, spiritual or physical, should be instilled in children with DS so that they can live normally with society despite their disabilities compared to normal children.

Apart from that, researchers should develop communication devices or software that can help children with DS in enhancing their skills in listening, mentioning and imitation because it has been proven in this research that these three skills have the potential to be nurtured in children with DS. The availability of such devices would definitely enhance the learning process. Therefore, researchers should develop teaching aids for children with DS so that they can increase their skills to the highest degree possible, as stated by Daunhauer et al. (2014) and Marshall et al. (2015) in their report.

4.2.2 Expert Interview

This section covers the data collection technique of semi-structured interviews. This interview is meant to support the literature that finds that not enough appropriate apps meet the learning requirements for DS children, which is a face-to-face interview with the teacher, parents and specialist.

The interview questions were based on four main components: research questions, teaching and learning theory (TLT), UCD procedure (user requirements) and findings in literature review. Before the interview was conducted, a few preparations for the interview have been done to ensure that the interview session runs smoothly. Table 4.6 describes the preparation before the actual interview.

Table 4.6: Pre-Interview preparation

Task	Sub-tasks	Activity
Planning	Identify the participants to be interviewed.	Identify their experience with learning and teaching with DS children
	Prepare official letter for permission to conduct the interview.	Provide a letter of permission that includes the objective of the interview and details about the research.
Developing	Prepare the Interview Form (See APPENDIX A)	Prepare what to say to interviewees when beginning the interview and also inform consent and confidentiality of interviewee confidentiality.
	What to do during the interview	Record and take notes.

The expert interview was done with seven experts that involved teachers, parents and specialists. It was held in Mei 2015. The interview form that shows the set of interview questions can be found in APPENDIX A. The seven experts involved experts with above five years of experience in teaching and learning with DS children and are willing to respond to the findings of the interview. Below is the description of each expert (see APPENDIX B for details):

Expert 1

His name is Dr. Haron bin Jaffar. He is 54 years old and has a Doctor of Philosophy (PhD). He is married and has a DS child aged 11 years old. Dr. Haron has been the

president of Persatuan Sindrom Down Malaysia (PSDM) for two consecutive sessions. He has 11 years of experience with the DS community or in teaching and learning sessions with DS students. He is fairly comfortable with computers and excited to be using technology with his DS child. He knows that DS students cannot learn without help from a parent or teacher.

Expert 2

Her name is Nor Shahida binti Mohd. Salleh, aged 44 years old. She received a Masters in Special Education in Hearing Disabilities in 2005 from Universiti Kebangsaan Malaysia. She was a Special Education teacher under the Special Education Integration Programme (Program Pendidikan Khas Integrasi- PPKI) for 3 years, from 2005 to 2008. From 2009 to 2011 she was the Assistant Director of Special Education, Curriculum Development Centre, Ministry of Education. And now she assumes duty as the Coordinator of PPKI in the field of LD, which commenced from 2012. She was a very dedicated teacher in special education for 11 years.

Expert 3

His name is Abd. Rahman bin Ramly. He is 51 years old. He was a special education teacher for 20 years. He had been teaching DS students for 16 years, which commenced in year 2000. He is now the coach of Special Education under the Ministry of Education since 2011. He also holds the position of Senior Assistant Special Education at Sekolah Kebangsaan Sultan Alam Shah 1, Petaling Jaya, Selangor. He is a very experienced teacher who teaches students with DS.

Expert 4

Her name is Wan Faridah binti Wan Ahmad. She is 53 years old. She has 13 years experience with DS students. She has a DS daughter who is 13 years old. Her experience began with attending a course of special education (Psychotherapy) for 2 years under the Department of Special Education, Ministry of Education, Putrajaya. Following that, she contributed as an instructor in the Department of Special Education, Ministry of Education, Putrajaya, for 6 years. And now she is a Special Education Teacher / student's therapist in PSDM for 5 years.

Expert 5

Her name is Siti Rozana binti Hj Hanifah. Her age is 42 years. She is the parent of a DS child aged 11 years old. She was together with PSDM as a member for 10 years. She is now a full-time housewife because she wants to concentrate on the care and development of her DS child at home. She gained a lot of experience in the care of DS children under PSDM. She is very grateful for it.

Expert 6

Her name is Prof. Dr. Murni binti Mahmud. She is 46 years old. She was educated with a Doctor of Philosophy (PhD), University of Manchester and now she is an Associate Professor at Kulliyyah of Information and Communication Technology, IIUM Gombak Campus. She has 5 years of experience with construction tools of learning using the computer for learning disabilities. Her areas of specialization are in Information, Computer and Communications Technology (ICT), other emergent Information Technologies, Human Computer Interaction, evaluation of Interaction Design, Social Science, Population and Demographic Studies, Ageing Technology for older people,

Multimedia Interface Design, evaluation of usability and user experience, and development and evaluation of mobile application.

Expert 7

Her name is Mahfuzah binti Zainol. She is 32 years old. She received her Master degree, BSc education (Hons) Occupational Therapy at Cardiff University, UK. She now assumes duty as the Assistant Director of Occupational Therapist under the Ministry of Education Malaysia since 2011. Her role while serving in the Special Education Service Center Putrajaya is the intervention of occupational therapy to children with special needs as early as age 2 years and 6 months until 16 years. Among the activities undertaken by her intervention are gross motor skills, fine motor skills, cognitive skills, self-management skills, posture and balance, and sensory integration. She has also released seven series of books namely Book 1: Guidelines Occupational Therapy for Students Special, Book 2: Manipulative Skills in Special Education, Book 3: Sensory in Special Education, Book 4: Cognitive Skills, Book 5: Skills Cutting, Book 6 : Colouring and Writing skills, Book 7: Exercise Books Pre-Writing Activities. Her books can be found in the Special Education Resource Centre, Parcel E, Putrajaya.

This interview is aimed to investigate the characteristics of DS children in the Malaysian environment, and the requirements of teaching and learning among them. In this case, the role of teachers and parents, and also the type of centre will give more revelatory insights to the research.

4.2.2.1 Findings from Experts Interview

The expert interview is done to obtain the themes for the Fuzzy questionnaire. The themes that have been obtained from this interview are provided in Table 4.7 below:

Table 4.7: The themes obtained from experts interview

Themes	Sub-Themes
The characteristics of students with DS	The physical characters of DS students
	The emotional characters of DS students (internally)
	The DS students' characters in a learning environment
The needs of DS students in learning session	The strengths of DS students
	The weaknesses of DS students
Learning methods	Identifying method of learning
	The strategies of learning
	The interaction learning of method
Requirements of technology learning	Identifying the needs of technology learning
	The structure (characteristics) that is essential to apply technology learning
	Appropriate technique of technology learning
Opinions / Suggestions	The opinion of the application of Al-Quran learning to students with DS
	The suggestions of content criteria for the learning app
	The suggestions of accessibility criteria for the learning app
	The rationale of the implementation of learning technology for students with DS

From the summary of the table above, there are five themes and fifteen sub-themes provided in the Fuzzy Questionnaire survey (Section 4.4) to find the appropriate elements of the learning requirements for DS students.

4.3 CASE STUDY 2

4.3.1 Observation Part 2

4.3.1.1 Scenario

Nowadays learning Quran for those with special needs has already gained the attention of the society, especially in Malaysia. Therefore, through the Faqeh project, students with DS have been introduced to learn Al-Quran with the Abahata (Al-Jabari) learning approach. This is a programme under the Faqeh project, University of Malaya that

began in December 2014. It is an effort carried out in groups in order to learn, know, and understand the Quran for children with special needs using the Abahata (Al-Jabari) method. This method is seemed to be the appropriate technique for children with disabilities or special needs to learn the Quran just like other normal children. The purpose of this observation was to evaluate the acceptability of the Abahata (Al-Jabari) learning Al-Quran method that was introduced to the DS children.

4.3.1.2 Materials and Methods

Participants

Eight DS children were selected to be the subject of this study. Several selection criteria were identified: a) the ages of the selected students were from 13 to 21 years old; b) the students have been diagnosed as DS; c) possess DS characteristics such as not being able to speak properly. Below is the description of each student:

Aisah

Aisah is twenty years old. She is a young girl with DS. Aisah is the fourth child among four siblings. Aisah had her early education at SMK PPKI, Kuala Lumpur. Aisah wears a prosthetic leg on the right side, therefore, her movements are quite limited and there are a few activities where she requires help from others. Aisah's advantage is that she can communicate well. She is friendly, gregarious and a very loving person.

Arman

Arman is nineteen years old. He is a young boy with DS. Arman has three siblings. Arman had his early education at SMK KIRAMAS, Kuala Lumpur. Arman likes to be entertained and sometimes he likes to act (playing a character in a cast). He also speaks

and interacts well. Arman already can recognise letters and read two syllables and can draw well.

Bijlal

Bijlal is thirteen years old. He is a boy with DS. Bijlal had his early education and studied in SK Taman Tun Dua, Petaling Jaya. Bijlal's advantage is that he can easily remember things and is very active. He is very gregarious although he sometimes loves teasing his friends.

Ermi

Ermi is twenty one years old. She is a young girl with DS. Ermi is the second of two siblings. Ermi had her early education at one of the schools in Kuala Lumpur. Ermi's advantage is that she is very good at writing and able to communicate well. She is also able to use the computer to perform simple tasks such as typing and so on.

Fathi

Fathi is fourteen years old. He is a boy with DS. Fathi is the second of two siblings. Fathi had his early education and schooling in CADS Enhancement Centre, Jalan Duta, Kuala Lumpur. Fathi's advantage is that he can easily memorize or remember a person's name and pronouncing goods. He is friendly, gregarious and a very loving person.

Husain

Husain is fifteen years old. He is a boy with DS. Husain is the fourth child of four siblings. Husain had his early education and studied at Sekolah Menengah Kebangsaan Bandar Menjalara, Kuala Lumpur. Husain's advantage is that he is very quiet and does

not display a lot of emotions. He can use a computer, good at colouring and loves to play the guitar.

Irdina

Irdina is fourteen years old. She is a young girl with DS. Irdina is the third child of four siblings. Irdina had her early education and schooling in CADS Enhancement Centre, Jalan Ledang, Kuala Lumpur. Irdina's advantage is that she can write and read well. She really likes to dance and teaches her friends what she knows. She is also a gregarious and very loving person.

Khamsiah

Khamsiah is fifteen years old. She is a young girl with DS. Khamsiah is the third of three siblings. Khamsiah had her early education and schooling in CADS Enhancement Centre, Jalan Duta, Kuala Lumpur. Khamsiah's advantage is she really loves to sing even though she cannot read. She loves beauty and is very fond of music. She is also able to perform household chores. She is friendly, sociable and very affectionate.

Trainers / Facilitators

A total of eight volunteer teachers spent time to practice learning Al-Quran using the Abahata (Al-Jabari) method to students with DS. This method was first introduced to students with DS. All instructors had already attended the course Training of Trainers (TOT), which was organized by the Yayasan Semesta Berdaftar, one of the foundations that introduced and handles the Abahata (Al-Jabari) method in Malaysia.

Modules and Procedures in the Al-Jabari learning Quran method

The Abahata (Al-Jabari) approach is totally different from other methods in teaching and learning the Quran, in which the syllabus of teaching and learning of the Quran contains four volumes that will be covered during a 30-hour encounter. The main criteria while developing this technique is to attract the student's interest and increase their motivation to learn Quran through an interactive way, thus, making it easier for them to understand the intended teaching modules . Before the learning process begins, the teacher (*Mudarris*) will assist the students on how to make *doa* through prayers. This activity is the usual routine that needs to be performed before the classes start, in order to seek permission from Allah SWT to gain a better understanding about Quranic learning. Then, the learning process will be continued through 'singing'. The method of learning through 'singing' is recommended in the teaching pedagogy, because it is considered as an attractive approach, which influences the psychology and mood of the students. In the Abahata (Al-Jabari) method, the main core of learning is focused on memory mind mapping. The *hija'iyyah* letters need to be remembered by each student through singing, which has the same rhythm with Badr Nasheed (*Selawat Badar*) and the song entitled "*Kitab* Quran". This method is applied because it coincided with the skills that have been studied previously, i.e. students with DS have strong skills in listening and mentioning.

The implementation of the Abahata (Al-Jabari) method of learning was delivered in stages in accordance with the time provisions that had been prepared. Teachers or trainers taught the students according to the learning topics that had been provided in order to ensure the target and learning goals can be achieved, which is to enable students to master the skills of reading and writing the Quran during the 30 hours that had been

allocated to this. Table 4.8 shows the syllabus of the Abahata (Al-Jabari) learning approach as the learning and teaching method.

Table 4.8: The syllabus of Abahata (Al-Jabari) technique.

Volume	Basic Learning	Time	Lesson Title
1	Recognise a single letter or vowel of ***Fathah***	4 hours	Read a single letter or vowel of ***Fathah***
			Write a single letter or vowel of ***Fathah***
2	Recognise cursive words, sounds i and u, letters that are not sounded, and nunnation assimilation.	6 hours	Read cursive words, sounds i and u, letters that are not sounded and nunnation assimilation.
			Write cursive words; the initial, middle and end of the verse.
			Write the vowel ***Kasroh***, ***Dhammah*** dan ***Tanwin***.
3	Knowing the laws in the Quran recitation like ***Mad***, ***Lin***, ***Al-Ghunnah*** laws, ***Izhar***, ***Idgham***, ***Ikhfa'*** and ***Iqlab***.	10 hours	Reading in Mad, Lin, Al-Ghunnah laws, Izhar, Idgham, Ikhfa' and Iqlab.
			Writing lettering containing ***Mad***, ***Lin***, ***Al-Ghunnah*** laws, ***Izhar***, ***Idgham***, ***Ikhfa'*** and ***Iqlab***.
4	***Qalqalah***, Dead ***Mim*** law, ***Mad*** markings, ***Wakaf*** (the stop sign) and ***Fawatihussurah***	10 hours	Read ***Qalqalah***, Dead ***Mim*** law, ***Mad*** markings, ***Wakaf*** (the stop sign) and ***Fawatihussurah***.

The syllabus for teaching and learning the Quran by the Abahata (Al-Jabari) method is covered over 30 hours, which is equivalent to 1 month and 2 weeks if each week had 5 meetings. Each meeting is for 1 hour or 60 minutes. However, if the meeting is held once a week, 30 hours can only be completed within 7 months and 2 weeks (Yusuf Sadiq, 2012). Nonetheless, based on previous experience, for students with DS, the Faqeh Pilot project made modifications to the meeting and included some improvements to the contents so that students with DS can be properly taught the Quran by the Abahata (Al-Jabari) method. The program for students with DS went on for five weeks in the bungalow Faqeh and three meetings were conducted in a week; with three hours

for each meeting. In the first half-hour of the meeting, students and teachers will start learning by reading ***ruqyah*** the dhikr en masse, after which the students will be divided into groups that were assigned to the learning session. Then, in the final half hour of study, the students and all the teachers regroup to strengthen the Bridge of Memory song.

4.3.1.3 Results: Findings from Observation Part 2

Observations were made during the course of learning the Quran by the Abahata (Al-Jabari) method. The program began with the recitation of verses of ***ruqyah*** led by Ustaz Shamsul which lasted for fifteen to twenty minutes. The students were very interested to hear the verses of ***ruqyah*** and some of them tried to follow the reading of this paragraph. The verses of ***ruqyah*** are also meant to receive the blessings of God and provide the feeling of calmness to the listeners. Although not completely calm, especially in terms of emotion, the serenity and the spirit can be seen to begin the learning among the students with DS. After that, learning sessions will take place in small groups and the session will be preceded by the Bridge of Memory song, so that students can absorb the melody and subtitles of this song in the mind and soul. The learning session continued with the introduction of the ***Hijaiyah*** letters and methods of writing letters is seen as strengthening the introduction. Then break sessions were held so that the students can relax and soothe their emotions. The last session is a session of strengthening of the Bridge of Memory with drums (***kompang***) beating. This observation found that DS students are more likely to play the drums (***kompang***) as they sang the songs in Bridge of Memory (see Figure 4.6 below). The situation is very different during the inauguration of the first group session learning in which the technique of applause, which was introduced by the Abahata (Al-Jabari) could not be adapted by the students with DS because when they clapped, their mouths could not make a sound, which meant

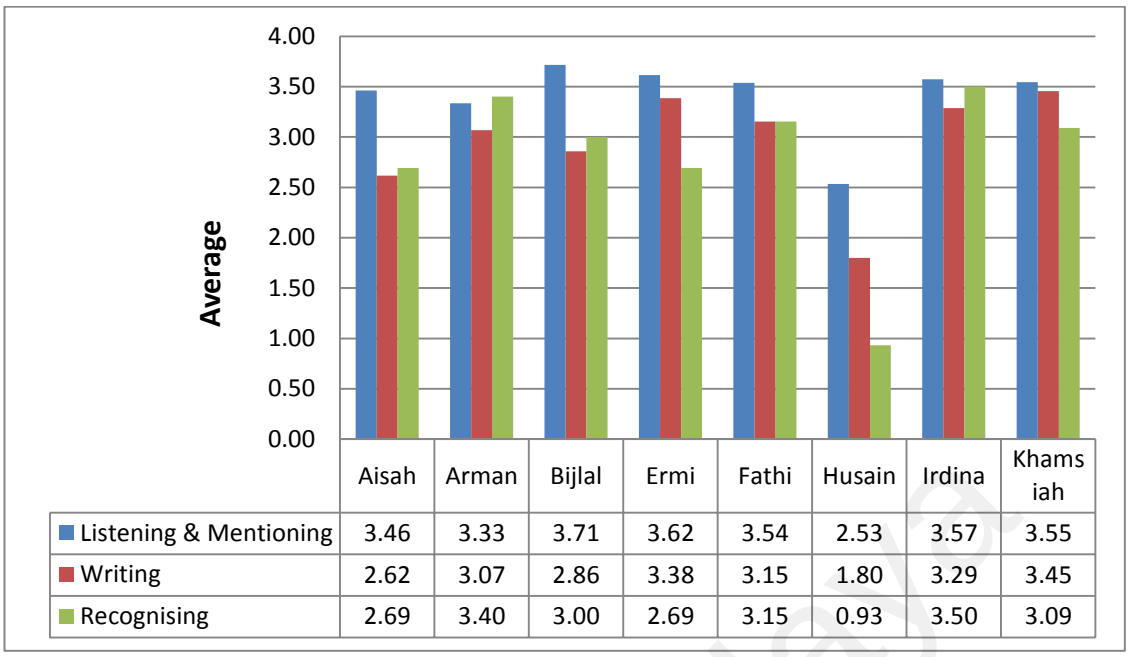
they could not speak (make sound); this is a disadvantage to those with Down syndrome because they cannot do or think about doing two things at once. Therefore, it can be seen here that drums beating can help them to sing (make sounds) better while their hands beat those drums (*kompang*).

Figure 4.6: Students with DS used the *Kompang* while singing the Bridge of Memory

After the observation, collection and analysis of data, the result shows that DS children can follow the lessons well despite not fulfilling the standard 30-hour encounter. In other words, they can follow the rules, but must take extra time. This analysis was using the four-point scale from 4 (Fast/accurate pronunciation and fluent reading), 3 (Slow/accurate pronunciation and fluent reading), 2 (Fast/accurate pronunciation and reading, Not fluent), and 1 (Fast or Slow/not accurate pronunciation and reading, Not fluent) as illustrated in Table 4.9 below:

Table 4.9: The description of the scale

Mark	Description value
4	Fast / Accurate pronunciation and Reading, Fluent
3	Slow / Accurate pronunciation and Reading, Fluent
2	Fast / Accurate pronunciation and Reading, Not Fluent
1	Fast or Slow / Inaccurate pronunciation and Reading, Not Fluent



	Aisah	Arman	Bijlal	Ermi	Fathi	Husain	Irdina	Khamsiah
Listening & Mentioning	3.46	3.33	3.71	3.62	3.54	2.53	3.57	3.55
Writing	2.62	3.07	2.86	3.38	3.15	1.80	3.29	3.45
Recognising	2.69	3.40	3.00	2.69	3.15	0.93	3.50	3.09

The percentage of respondents that could : Listening & Mentioning = 88%
Writing = 63%
Recognising = 63%

Figure 4.7: Analysis on DS students with skills in Abahata (Al-Jabari) method.

Figure 4.7 shows that the students' performances in different skills varied from each other. After 5 weeks of observation, Aisah was found to be having listening & mentioning, writing, and recognising skills with the average scores of 3.46, 2.62 and 2.69 respectively. Arman showed a good recognising skill (3.40), along with listening & mentioning (3.33), and writing skills (3.07). Bijlal had average scores of 3.71 in listening and mentioning, 2.86 in writing, and 3.00 in recognising. Ermi managed to get 3.62 in listening and mentioning, 3.38 in writing, and 2.69 in recognising. Fathi showed good listening and mentioning skills (3.54), along with both writing and recognising skills (3.15). Hussain was found to be having listening and mentioning, writing, and recognising skills with the average scores of 2.53, 1.80 and 0.93 respectively. Meanwhile, Irdina managed to get 3.57 in listening and mentioning, 3.29 in writing, and 3.50 in recognising skill. The final student was Khamsiah who did well in listening and mentioning, writing and recognising skills, with average scores of 3.55, 3.45, and 3.09, respectively. Table 4.10 shows the mean and standard deviation possessed by each skill.

Table 4.10 shows the statistics for listening and mentioning by gender, with the mean for Male is 3.28 and the standard deviation was 0.54, while the mean for Female is 3.55 and the standard deviation is 0.06. For the level of achievement, 100% of students successfully completed Volume 1, while only 25% of students reached the level of Volume 2. Whereas, no students achieved the level of Volume 3 and 4.

Table 4.10: Statistic of Skill by Gender

Group of Statistic					**Level of Achievement (N)**	
	Gender	N	Mean	Standard deviation	Volume 1	Volume 2
Listening & Mentioning	Male	4	3.28	0.52	8	2
	Female	4	3.55	0.06		
Writing	Male	4	2.72	0.63		
	Female	4	3.19	0.39		
Recognising	Male	4	2.62	1.14		
	Female	4	2.99	0.39		

Table 4.11: Correlations and Descriptive Statistics For Skill Study Variables

	M (SD)	**Listening & Mentioning**	**Writing**	**Recognising**
Listening and Mentioning	3.41 (0.37)		0.843	0.860
Writing	2.95 (0.54)			0.858
Recognising	2.81 (0.81)			

Table 4.11 shows the correlations among the variables skills studied in this observation. The analysis of correlation among the variables skills studied presents that listening and mentioning skills were strong positively correlated with writing ($r = 0.843$, $p = 0.001$) and recognising ($r = 0.860$, $p = 0.001$). Meanwhile, writing skill was strong positively correlated with recognising ($r = 0.858$, $p = 0.001$).

From the summary in the analysis above, the mean values of male and female students significantly show that female students scored higher in listening and mentioning (reading) than male students. This shows that there are significant gender differences in reading in the Abahata (Al-Jabari)'s program. Female students prefer and tend to read well than the males. In addition, for the writing part, female students have a 'fluent' score (3) while male students have 'not fluent' score (2). This shows that female students also perform well in writing than males. This is because male students have a lack of focus and always want to play (make other things). Therefore, teachers should focus more on male students during the process of reading in the Abahata (Al-Jabari)'s method. Furthermore, both male and female students have a 'not fluent' score (2) in recognising. This is because DS students are weak in memory skill, so they cannot perform well in recognising. Therefore, it is recommended that this study should focus on how to increase the memory skill. Apart from that, researcher should build the user requirement model that will help software or app developers in enhancing children with DS in memorising skill (cognitive). Meanwhile, if viewed from the level of achievement there was no difference between the volume level of achievement for both genders, male and female. All DS students can complete Volume 1 well and only two students are able to reach Volume 2. This means that DS students can study the Quran with this Abahata (Al-Jabari) method but it requires a longer time to spend all the modules available.

4.3.2 Facilitators' Interview

The facilitators' interview is done with five teachers who were facilitators during the Al-Jabari learning programme. As the objective of this research is to find a suitable method for reciting the Quran and assisting apps for reading Quranic words, the interview was done directly to find out the suitability of the Abahata (Al-Jabari) method in learning how to read Quran for DS students. The objective of this activity is to get

further information about its suitability. Generally, this activity helped to reveal some of the requirements which required building a useful computerized learning environment for them.

Interview is one of the techniques used in the preliminary study stage which was carried out in this study. This interview was conducted to gain the facilitator's experience and success of the program. The goals of creating and using the interview technique are to make a user-centred design possible and to communicate what is being learned with the real people (user). They put a face on the user – a memorable, engaging, and actionable image that serves as the design target.

The facilitators' interview was done with five experts that involved teachers acting as facilitators in the Abahata (Al-Jabari) programme. The interview was conducted under personas instrument. Table 4.12 below is the summary profile of each facilitator:

Table 4.12: The summary of the facilitators' profile.

Facilitator's name	**Age**	**Detailed information of facilitator**
Muhamad Sayuti bin Sabdan	29 years old	He now lives in Beaufort, Sabah, and continued his studies at a PhD level in the field of Islamic studies. He has experience as a RA at the University of Malaya for 3 years, and while at UM, he was actively involved as a facilitator in Faqeh for 2 years to teach special children in reciting the Quran.
Noor Fadilah binti Md Aslie	29 years old	She is currently a teacher of Islamic education in Sabah. She holds a master's degree in Quranic recitation at the University of Malaya. Her experience during her study in UM is as an RA and was actively involved as a facilitator in Faqeh before being appointed as a teacher.

Table 4.12: The summary of the facilitators' profile. (continued)

Facilitator's name	Age	Detailed information of facilitator
Nurul Nadrah binti Kamaruzaman	28 years old	She is from Kuala Lumpur and currently resides with her family in Sungai Buloh, Selangor. She graduated with a Master of Computer Science, and her projects geared to the needs of computerized teaching aids among students with Autism. She has been a research assistant in the University of Malaya for 5 years, and also a facilitator in Faqeh for 3 years to teach special children in reciting the Quran.
Nur Madihah binti Jafar	28 years old	She came from Batu Pahat, Johor and currently resides with her family in Bandar Sri Damansara, KL. She graduated with a Master of Computer Science, and her project is geared to identifying the capability of reciting and memorizing the Quran among autism students with computer aids. She is currently working as a tuition teacher at home. She had experience as a research assistant in the University of Malaya for 3 years, and at the same time she was actively involved as a facilitator in Faqeh to teach special children in reciting the Quran.
Siti Norhaiza binti Muhamad	28 years old	She came from Kuala Terengganu, Terengganu and currently resides with her family in Bukit Mahkota, Selangor. She is a Faqeh administrator and was involved in the management of Faqeh for 3 years. She graduated with a Diploma in Management and has been actively involved in helping the management of Faqeh and as a facilitator for teaching special children in reciting the Quran.

4.3.2.1 Findings from Facilitators' Interview

The results of the observation done above is reinforced by interviewing the facilitators who participated and are involved in this program. Below are excerpts of the interview that were made:

Ustaz Sayuti

Ustaz Sayuti is 29 years old; now he is lives in Beaufort, Sabah with his family. He works as a PhD candidate at University Sabah and has 3 years of experience in teaching

children with autism and DS. He explained some of his encounters with these DS children while teaching. He explained:

"*Alhamdulillah*, the DS students can follow the reading ***ruqyah*** congregation, in fact they were sitting and reading together. Meanwhile, based on my observation of the implementation of teaching and learning by using the Abahata (Al-Jabari) method, I found it was easy for the students to follow this rule because it is in the form of a rhythm, which these DS students really like and would join together to sing. At the end of the teaching and learning process, the performing arts activities were carried out by using learning aids such as drums (***kompang***), laptops and smart phones to offer prayers of Badr, bridge memory, remembrance therapy and Islamic songs (***nasyid***). This activity is to enhance self assurance in them."

Ustaz Sayuti is one of the instructors of this program. He is very grateful these DS students can execute this program with the Abahata (Al-Jabari) method well. At the level of reading ***ruqyah***, he said, all students can give a very positive collaboration where they can all sit together listening and reading the ***ruqyah*** and there are some of them that can speak or memorize the words of ***ruqyah***. At the level of teaching and learning, he found that it was very easy for DS students to follow the methods of Abahata (Al-Jabari) because it is in the form of rhythm and song. He also found that the students very much liked and enjoyed using the teaching aids and ***Kompang*** during a performance run at the end of each session of teaching and learning. This was a great help in increasing the level of self-confidence of every student.

Ustazah Dilla

Ustazah Dilla is 29 years old. She works as a teacher and has 2 years of experience in teaching children with autism and DS. She is one of the instructors for this program. She said at the initial stage of the reading session's ***ruqyah***, there were very few students who wanted to follow the session; however, eventually all students were interested to sit together in a circle to read the ***ruqyah***. She explained some of her encounters with these DS children while teaching. She explained:

"At the beginning, during ***ruqyah*** there can be seen only a handful of students who wanted to take a book to read ***ruqyah***, but eventually all students were interested to sit down together to read. Throughout the process of teaching and learning , it can be seen the development of each student, whereby some students were less interested in reading ***hijaiyah*** according to the method of the Abahata (Al-Jabari), but the facilitators made changes by using mini whiteboards and so on. At the end of the teaching and learning process, the students made a presentation to show what they went through that day with drums (***kompang***) beating. Each student seemed so keen to make their presentation."

During the teaching and learning process, Ustazah Dilla could see a positive development of each student starting from the beginning of the program until the end of the program initiated. There were students who were less interested in reading ***hijaiyah*** according to the methods of Abahata (Al-Jabari), but the facilitators modified their teaching and learning to make it more attractive to students. For example, they used learning aid tools such as drums (***kompang***) for each session presentation where each student was very keen to make their presentation using these tools.

Ustazah Nadrah

Ustazah Nadrah is 28 years old. She works as a research assistant and has 3 years of experience in teaching children with autism and DS. She is one of the instructors for this program. She explained some of her encounters with these DS children while teaching. She explained:

"Learning the Quran among the DS is apparently very encouraging. The Abahata (Al-Jabari) method is viewed as very suitable to be implemented to teach these children in reciting the Quran because it is very interactive and can attract students with DS to recognise the Quran. The only thing that needs to be highlighted is the applause method recommended by the Abahata (Al-Jabari) method which was found not suitable to be applied to the DS students because of their poor physical condition. I love the methodology provided by the facilitators, where they used the ***Kompang*** instrument as an alternative to the applause method. The applause drums seemed very encouraging to the DS students in mentioning the ***hijaiyah*** letters. "

During the teaching and learning process, Ustazah Nadrah stated that DS students were interested in reading ***hijaiyah*** according to the methods of Abahata (Al-Jabari), but the clap technique in the Abahata (Al-Jabari) method could not be applied with the DS students because of the ability in their physical function. The facilitators modified their teaching and learning to make it more attractive to students whereby they used the instrument of '***kompang'*** as a learning aid tool for the singing session. Its can be seen that each student really loved using it when they made their presentations.

Ustazah Madihah

Ustazah Madihah is 28 years old. She works as a tuition teacher and has 3 years of experience in teaching children with autism and DS. She is one of the instructors for this

program. She explained some of her encounters with these DS children while teaching. She explained:

"The Abahata (Al-Jabari) method is very encouraging for DS students to recite the Quran because this method is seen to be very interactive and can attract DS students to recognise and learn the Quran perfectly. The uses of the ***Kompang*** instrument is seen as a good choice in lieu of the applause method, where DS students were unable to follow it properly. DS students were encouraged to sing while reading the ***hijaiyah*** letters."

During the teaching and learning process, Ustazah Madihah said that the Abahat (Al-Jabari) method is suitable for DS students since they were very interested in reading ***hijaiyah***, but the clap technique in the Abahata (Al-Jabari) method could not be applied to the DS students because of their physical limitations. The '***kompang'*** instrument as a learning aid to replace the clap technique is seen as a suitable technique for DS students in singing sessions.

Ustazah Haiza

Ustazah Haiza is 28 years old. She is a Faqeh administrator and was involved in the management of Faqeh. She has 3 years of experience in teaching children with autism and DS. She is one of the instructors for this program. She explained some of her encounters with these DS children while teaching. She explained:

"Learning the Quran among the DS apparently is very impressive. The Abahata (Al-Jabari) method is seen as very suitable to be implemented to teach these children in reciting the Quran because this method is very interactive and can attract the students to recognise the Quran. The syllabus is also seen as suitable for students, but here the DS students require a longer time to complete the syllabus. I think if there are suitable teaching and learning tools, especially computerized tools, I believe that DS students

will be able to learn faster. For example, the facilitator used *Kompang* as a tool during the session which really helped students to sing the song better."

During the teaching and learning process, Ustazah Haiza stated that the method of Abahata (Al-Jabari) is suitable for DS students reading the Al-Quran because of its very interactive methods. The syllabus is also very suitable for students to learn but for DS students, they need a longer time to finish the syllabus. The uses of suitable and good teaching and learning tools is seen as very helpful to the students and encourages the students to learn.

From the summary of interviews with teachers, it was found that the Abahata (Al-Jabari) method can be accepted well by DS students but they need more time to complete all four volumes if compared to normal students. This is because DS students have a slower development process in learning. Furthermore, this study also found that students with DS are more likely to play the *kompang* (Malay traditional musical instrument similar to a drum) when they sing the songs in memory strengthening sessions. This situation is very different during the first consolidation i.e. in group learning sessions where the applause technique introduced by Abahata (Al-Jabari) methods could not be adapted for students with DS because when they clap their hand, their mouths are not producing the sound, which is a disadvantage to those who DS. Therefore, it can be seen here that beating the *kompang* can help them sing (using the voice) better while their hands beat the *kompang*.

4.4 FUZZY QUESTIONNAIRE

When using the FDM method in a study, there is a sequence of steps to be followed as shown in Chapter 3. A questionnaire survey was the main research tool in this study. The study interviewed seven experts, with the experience of five years and above, to identify methods and strategy of learning for students with DS. Based on the results of interviews with these experts, a set of questionnaire was designed with reference to related literatures and the interviews with experts. The questionnaire was divided into three sections. The first section was about the strengths of DS students in a learning session and the second section was about the methods of learning, while the last section was about the structure of learning technology for DS students. A seven point linguistics scale was used and a higher point indicated a higher importance as shown in Table 3.2 in Chapter 3.

In the fuzzy questionnaire there are 85 types of items (see APPENDIX C) that are divided into four parts, namely part A (Demography expert), part B (Identify the characteristics), part C (Identify method of learning); and part D (Identifying the needs of technology learning). Table 4.13 shows the division in the questionnaire and the number of items for each part. The formation of these items is the result of Delphi interviews of seven experts (Section 4.2.2).

Table 4.13: Parts, Elements and Items contained in the Fuzzy Questionnaire.

Part	Elements	Item	Number of Item/ Sub-Item
A	Demographic Experts	Faculty/School/Center/Association Department/Division Occupational Area of expertise Experience with Down syndrome community.	4
B	Identify the characteristics of students with DS	The character of students with DS. The physical characteristics of DS students.	6
		The emotional characteristics of DS students (internally).	3
		The DS students' characteristics in a learning environment.	3
		The needs of DS students in a learning session.	5
		The strengths of DS students in a learning session.	5
		The weaknesses of DS students in a learning session.	4
		The opinion about the application of Al-Quran learning to the students with DS.	3
C	Identify method of learning for DS students and its strategy of learning	The method of learning that is perceived most suitable to DS students.	7
		The strategies of learning that is deemed appropriate for students with DS.	4
		The interaction learning of method that is deemed appropriate for students with DS.	6
		The suggestions of content criteria for the learning apps that will be developed for DS students.	10
D	Identifying the needs of learning technology to assist in the teaching and learning process.	The need of learning technology in their teaching and learning process.	4
		The structure (characteristics) is essential to apply learning technology primarily to assist the DS students.	6
		The form (technique) deemed appropriate technology learning for DS students (in terms of colours, images, and other characteristics).	5
		The rationale of the implementation of learning technology for students with Down syndrome.	4
		The suggestions of accessibility criteria for learning apps that will be developed for DS students.	6

4.4.1 Data analysis

The population is in the field of teaching and learning for children with DS. As the field of teaching and learning includes various parties, those who deal directly with students with DS have been selected, including teachers, parents and therapists. The subjects were teachers of special education, parents of DS students and therapists of the department of special education under the Malaysian government. They were contacted and informed early of the intention to survey. The questionnaire was distributed after permission was obtained. Researchers will ask them about characteristics, learning methods and the needs of learning technology. Finally, a total of 50 questionnaires were distributed, and more than 36 were returned valid. A valid response rate was 72%.

4.4.1.1 Findings: Information of Experts (Part A)

In this study, 30 experts were chosen to answer the Fuzzy questionnaire based on Jones and Twiss (1978), which is 10 to 50 of experts needed to answer the questionnaire. The information of the experts in Table 4.14, Table 4.15, Table 4.16 and Table 4.17 below includes the information about the Faculty/School/Center/Association that the experts are involved, occupational of the experts, experts' area of expertise, experience with DS children or its community.

Table 4.14: Expert information by School or Association

Name of School or Association		**The number of Participants**	**Frequency**	**Percentage (%)**
School	Sekolah Kebangsaan Pendidikan Khas (Integrasi), Meru Selangor	8	8	27
The Association	Yayasan Pendidikan Al-Quran Anak Istimewa (FAQEH)	6	22	73
	Persatuan Sindrom Down Malaysia (PSDM)	16		
Total			30	100

Table 4.14 shows the information about the experts by school or association. The school involved is Sekolah Kebangsaan Pendidikan Khas (Integrasi), Meru, Selangor. Meanwhile, the association involved is Yayasan Pendidikan Al-Quran Anak Istimewa (Faqeh) and Persatuan Sindrom Down Malaysia (PSDM). Based on the table above, the association has a high percentage that is 73%, i.e. 22 experts. The number of participants from these associations is appropriate because the focus of this study is more to teaching and learning especially in reciting the Quran for the DS children. Furthermore, these associations especially Faqeh is focusing on teaching and learning and also self-development on the DS children. Besides that, they have reciting Quran classes for DS children. Subsequently, the number of experts from the school showed the frequency of eight experts with 27%. Experts from the school consists of Muslim teachers who teach DS students and have experience in teaching and learning withchildren with DS.

Table 4.15: Expert information in the field of Occupational

Occupational Field	**Frequency**	**Percentage (%)**
Non-academic professional	10	33
Academic professional	15	50
Technical	2	7
Not Working		0
Others	3	10
Total	30	100

Table 4.15 shows the information by category in the field of employment. The field of academic work professional showed a high frequency which is 15 experts with 50% compared to the non-academic professional categories with a frequency of 10 experts (33%). The technical category showed a frequency of 2 experts (7%) and other fields have a frequency of 3 experts with 10%. The other category is that there exist volunteers from the university students.

Table 4.16: Expert Information by Area of Expertise

Area of Expertise	Frequency	Percentage (%)
Special education	11	37
Special education - Therapy	1	3
Islamic education	2	7
Parent of DS child	13	43
Others	3	10
Total	30	100

Teacher = 47%

Table 4.16 shows the information experts in the field of expertise. The number of experts in the category parent of a DS child showed a high frequency that is 13 experts with 43%. On the other hand, special education areas of expertise point to the frequency of 11 experts with 37%. Field of expertise in special education (therapy) shows one expert with 3% compared with the field of Islamic education of expertise of two experts (7%). Other categories also have 3 experts (10%) because of the volunteers at the centres consisting of university students. The data in the field of a profession as a teacher is 14 respondents with the percentage of 47%.

Table 4.17: Expert information by Experience with DS

Years of Experience	Frequency	Percentage (%)
No experience	0	0
Less than 1 year	2	6.7
Less than 2 year	8	26.7
2 - 5 years	8	26.7
6–10 years	8	26.7
10 years on	4	13.3
Total	30	100

Table 4.17 shows the information experts according to experience with DS children. The number of experts who have experience with DS children in the category of less

than 2 years experience, 2 to 5 years, and 6 to 10 years each have the same frequency of 8 experts with 26.7%. For the category of less than 1 year experience, it gained frequency of 2 experts (6.7%) and category of 10 years' experience gained on the frequency of 4 experts with 13.3%

4.4.1.2 Findings: Threshold value for Items Questionnaire.

Researchers have analysed the data using the FDM approach through Step 3 to 7 (see Section 3.3.1 in Chapter 3) to answer the research questions that have been expressed. In order to see the degree of agreement among the experts, the findings of all the items have been analysed by determining the distance between two fuzzy numbers to determine the threshold value d as follows:

$$d(\tilde{m}\tilde{n}) = \sqrt{\frac{1}{3}[(m_1 - n_1)^2 + (m_2 - n_2)^2 + (m_3 - n_3)^2]}$$

Hussin, Alias and DeWitt (2013), and Rosman, Alias and Rahman (2014), state that to analyse the data, the distance between two fuzzy numbers are calculated by measuring the deviation of the average value between the experts, whereas the criteria to be used to assess the expert group consensus is based on the degree of agreement that is more than 75%. Table 4.18, Table 4.19 and Table 4.20 shows the threshold value for the 81 items in Part B, Part C and Part D.

Table 4.18: The Threshold value for Part B

RESPONDENT	B - CHARACTERISTICS OF DOWN SYNDROME (DS)																											
	B1 - CHARACTER DS												B2 - LEARNING NEEDS OF DS					B3 - THE STRENGTHS OF DS					B4 - THE WEAKNESSES OF DS				B5 - OPINION ABOUT AL-QURAN LEARNING		
	B11	B12	B13	B14	B15	B16	B17	B18	B19	B110	B111	B112	B21	B22	B23	B24	B25	B31	B32	B33	B34	B35	B41	B42	B43	B44	B51	B52	B53
1	0.180	0.196	0.296	0.448	0.185	0.706	0.080	0.106	0.170	0.046	0.050	0.122	0.021	0.032	0.191	0.025	0.168	0.199	0.040	0.052	0.040	0.097	0.154	0.186	0.239	0.035	0.046	0.056	0.051
2	0.212	0.093	0.069	0.155	0.078	0.124	0.472	0.446	0.139	0.046	0.050	0.192	0.021	0.233	0.082	0.025	0.044	0.061	0.216	0.052	0.040	0.097	0.105	0.086	0.051	0.035	0.046	0.056	0.051
3	0.057	0.661	0.559	0.155	0.078	0.124	0.177	0.150	0.170	0.046	0.050	0.495	0.316	0.233	0.082	0.238	0.224	0.061	0.216	0.052	0.248	0.160	0.397	0.366	0.312	0.241	0.107	0.097	0.102
4	0.212	1.139	0.069	0.155	0.670	0.706	0.177	0.150	0.170	0.596	0.609	0.495	0.316	0.032	0.191	0.025	0.044	0.352	0.040	0.052	0.248	0.160	0.105	0.086	0.051	0.241	0.046	0.056	0.051
5	0.180	0.319	0.296	0.237	0.185	0.275	0.215	0.242	0.540	0.046	0.376	0.495	0.807	0.161	0.320	0.025	0.168	0.334	0.178	0.188	0.380	0.295	0.154	1.150	0.615	0.152	0.046	0.056	0.051
6	0.057	0.319	0.296	0.105	0.185	0.275	0.080	0.106	0.170	0.259	0.246	0.192	0.021	0.032	0.191	0.025	0.044	0.199	0.040	0.052	0.248	0.160	0.154	0.186	0.239	0.035	0.107	0.097	0.102
7	0.057	0.196	0.069	0.105	0.078	0.275	0.080	0.106	0.412	0.259	0.246	0.359	0.539	0.032	0.082	0.025	0.168	0.061	0.040	0.052	0.040	0.097	0.154	0.186	0.239	0.035	0.046	0.097	0.102
8	0.180	0.319	0.296	0.237	0.078	0.275	0.177	0.150	0.444	0.390	0.050	0.359	0.601	0.528	0.946	0.025	0.518	0.061	0.040	0.501	0.303	0.097	0.288	0.315	0.370	0.152	0.046	0.056	0.051
9	0.180	0.196	0.255	0.155	0.078	0.275	0.080	0.150	0.170	0.259	0.246	0.359	0.539	0.032	0.191	0.025	0.044	0.061	0.040	0.188	0.248	0.160	0.154	0.186	0.239	0.035	0.107	0.097	0.102
10	0.057	0.319	0.296	0.237	0.366	0.151	0.080	0.106	0.170	0.259	0.246	0.192	0.316	0.032	0.320	0.158	0.044	0.352	0.040	0.052	0.303	0.160	0.154	0.186	0.239	0.837	0.046	0.056	0.051
11	0.180	0.319	0.425	0.237	0.318	0.275	0.215	0.242	0.139	0.390	0.376	0.487	0.664	0.161	0.361	0.158	0.168	0.352	0.178	0.188	0.303	0.295	0.288	0.315	0.370	0.152	0.046	0.056	0.051
12	0.057	0.319	0.296	0.237	0.366	0.151	0.080	0.106	0.170	0.259	0.246	0.192	0.316	0.032	0.320	0.158	0.044	0.352	0.040	0.052	0.303	0.160	0.154	0.186	0.239	0.837	0.046	0.056	0.051
13	0.180	0.319	0.425	0.237	0.078	0.275	0.215	0.242	0.139	0.259	0.246	0.359	0.539	0.032	0.191	0.025	0.044	0.656	0.040	0.052	0.607	0.160	0.701	0.186	0.239	0.035	0.107	0.097	0.102
14	0.180	0.319	0.296	0.237	0.318	0.275	0.215	0.242	0.170	0.046	0.050	0.192	0.021	0.161	0.320	0.158	0.168	0.199	0.040	0.501	0.040	0.295	0.154	0.366	0.312	0.152	0.046	0.056	0.051
15	0.806	0.093	0.069	0.105	0.185	0.151	0.215	0.106	0.412	0.596	0.609	0.192	0.021	0.032	0.191	0.158	0.044	0.334	0.178	0.188	0.248	0.160	0.397	0.669	0.615	0.035	0.046	0.097	0.051
16	0.504	0.319	0.255	0.237	0.318	0.275	0.215	0.242	0.540	0.390	0.376	0.487	0.021	0.161	0.320	0.158	0.168	0.334	0.178	0.188	0.380	0.295	0.288	0.315	0.370	0.152	0.046	0.056	0.051
17	0.057	0.942	0.842	0.105	0.670	0.706	0.080	0.106	0.444	0.046	0.050	0.122	0.316	0.161	0.191	0.238	0.168	0.199	0.040	0.052	0.303	0.097	0.701	0.186	0.615	0.152	0.046	0.056	0.051
18	0.180	0.360	0.842	0.448	0.366	0.275	0.215	0.242	0.412	0.259	0.246	0.359	0.021	0.032	0.191	0.025	0.044	0.199	0.040	0.188	0.248	0.160	0.154	0.366	0.239	0.035	0.046	0.056	0.051
19	0.180	0.319	0.425	0.105	0.185	0.151	0.080	0.106	0.412	0.259	0.376	0.359	0.021	0.161	0.191	0.158	0.168	0.199	0.040	0.052	0.248	0.160	0.154	0.086	0.051	0.152	0.046	0.056	0.051
20	0.212	0.093	0.069	0.155	0.185	0.151	0.080	0.150	0.139	0.046	0.246	0.122	0.296	0.032	0.191	0.025	0.044	0.199	0.040	0.052	0.040	0.097	0.154	0.186	0.239	0.035	0.107	0.097	0.102
21	0.212	0.093	0.069	0.155	0.078	0.124	0.177	0.150	0.170	0.046	0.050	0.192	0.296	0.233	0.082	0.238	0.224	0.061	0.216	0.206	0.040	0.097	0.105	0.086	0.051	0.241	0.107	0.097	0.102
22	0.212	0.093	0.069	0.155	0.078	0.124	0.177	0.150	0.170	0.046	0.305	0.192	0.316	0.233	0.320	0.238	0.224	0.061	0.216	0.206	0.040	0.097	0.105	0.086	0.051	0.152	0.046	0.056	0.051
23	0.180	0.196	0.069	0.105	0.078	0.151	0.177	0.150	0.139	0.259	0.246	0.192	0.296	0.032	0.191	0.025	0.518	0.199	0.216	0.052	0.248	0.160	0.105	0.315	0.239	0.035	0.046	0.056	0.051
24	0.057	0.319	0.069	0.105	0.185	0.151	0.080	0.106	0.139	0.259	0.246	0.359	0.296	0.032	0.191	0.025	0.044	0.352	0.216	0.206	0.607	0.695	0.154	0.186	0.239	0.035	0.107	0.097	0.102
25	0.057	0.196	0.296	0.237	0.318	0.275	0.215	0.106	0.444	0.046	0.050	0.122	0.316	0.161	0.664	0.158	0.168	0.061	0.178	0.188	0.380	0.097	0.154	0.086	0.051	0.152	0.046	0.056	0.051
26	0.180	0.196	0.255	0.105	0.318	0.124	0.177	0.150	0.444	0.292	0.305	0.192	0.021	0.161	0.361	0.158	0.168	0.061	0.178	0.206	0.040	0.097	0.288	0.315	0.370	0.152	0.046	0.056	0.051
27	0.057	0.093	0.296	0.237	0.185	0.706	0.177	0.446	0.444	0.292	0.050	0.359	0.021	0.233	0.082	0.238	0.224	0.061	0.040	0.052	0.040	0.695	0.105	0.186	0.051	0.035	0.107	0.097	0.102
28	0.212	0.093	0.069	0.448	0.078	0.124	0.472	0.446	0.139	0.879	0.892	0.779	0.021	0.032	0.664	0.025	0.044	0.061	0.216	0.206	0.040	0.097	0.397	0.669	0.615	0.152	0.046	0.056	0.051
29	0.057	0.661	0.559	0.448	0.670	0.706	0.177	0.106	0.444	0.596	0.305	0.122	0.021	0.161	0.946	0.238	0.168	0.199	0.178	0.052	0.607	0.695	0.154	0.186	0.615	0.035	0.046	0.056	0.051
30	0.180	0.360	0.842	0.155	0.185	0.151	0.080	0.106	0.728	0.596	0.892	0.779	0.316	0.032	0.191	0.025	0.224	0.199	0.040	0.052	0.248	0.160	0.154	0.186	0.312	0.035	0.046	0.056	0.051

* The first condition has been complied with because the threshold value for most items are ≤ 0.2

Table 4.19: The Threshold value for Part C

RESPONDENT	C - IDENTIFY METHODS AND STRATEGY OF LEARNING																										
	C1 - METHODS OF LEARNING							C2 - STRATEGIES OF LEARNING				C3 - METHOD OF INTERACTION LEARNING						C4 - SUGGESTIONS OF CONTENT CRITERIA									
	C11	C12	C13	C14	C15	C16	C17	C21	C22	C23	C24	C31	C32	C33	C34	C35	C36	C41	C42	C43	C44	C45	C46	C47	C48	C49	C410
1	0.045	0.041	0.028	0.194	0.234	0.256	0.234	0.281	0.277	0.256	0.224	0.515	0.201	0.189	0.528	0.508	0.456	0.224	0.267	0.024	0.023	0.028	0.223	0.027	0.203	0.273	0.042
2	0.112	0.114	0.140	0.199	0.159	0.138	0.159	0.114	0.117	0.138	0.169	0.176	0.193	0.204	0.161	0.180	0.231	0.169	0.129	0.137	0.134	0.153	0.223	0.132	0.190	0.122	0.126
3	0.112	0.114	0.140	0.199	0.159	0.138	0.159	0.114	0.117	0.138	0.169	0.038	0.055	0.068	0.032	0.048	0.161	0.038	0.027	0.137	0.134	0.153	0.171	0.132	0.190	0.122	0.126
4	0.282	0.281	0.254	0.194	0.528	0.256	0.234	0.041	0.041	0.031	0.038	0.038	0.055	0.068	0.032	0.048	0.095	0.038	0.027	0.024	0.023	0.028	0.035	0.027	0.190	0.122	0.126
5	0.045	0.041	0.028	0.489	0.036	0.031	0.159	0.114	0.117	0.138	0.224	0.219	0.055	0.068	0.032	0.048	0.095	0.038	0.027	0.024	0.023	0.028	0.035	0.027	0.203	0.036	0.267
6	0.282	0.281	0.254	0.194	0.234	0.256	0.234	0.281	0.277	0.256	0.224	0.219	0.201	0.189	0.233	0.213	0.161	0.224	0.267	0.259	0.263	0.241	0.223	0.263	0.203	0.273	0.267
7	0.282	0.281	0.254	0.194	0.036	0.256	0.234	0.041	0.277	0.256	0.224	0.219	0.201	0.189	0.233	0.213	0.161	0.224	0.267	0.259	0.263	0.241	0.223	0.263	0.203	0.273	0.267
8	0.045	0.041	0.028	0.065	0.036	0.031	0.036	0.041	0.041	0.031	0.038	0.038	0.055	0.068	0.161	0.180	0.095	0.038	0.027	0.024	0.023	0.028	0.035	0.027	0.055	0.036	0.042
9	0.112	0.114	0.140	0.065	0.159	0.138	0.159	0.114	0.117	0.138	0.038	0.038	0.193	0.204	0.161	0.180	0.231	0.169	0.129	0.137	0.023	0.153	0.035	0.027	0.055	0.122	0.126
10	0.112	0.114	0.140	0.199	0.159	0.138	0.159	0.114	0.117	0.138	0.169	0.176	0.193	0.204	0.161	0.180	0.231	0.520	0.129	0.137	0.134	0.153	0.171	0.132	0.190	0.122	0.635
11	0.282	0.041	0.028	0.065	0.036	0.031	0.036	0.041	0.041	0.031	0.038	0.038	0.497	0.189	0.032	0.048	0.095	0.224	0.027	0.259	0.023	0.241	0.035	0.263	0.055	0.122	0.126
12	0.112	0.114	0.140	0.199	0.159	0.138	0.159	0.114	0.117	0.138	0.169	0.176	0.193	0.204	0.161	0.180	0.231	0.520	0.129	0.137	0.134	0.153	0.171	0.132	0.190	0.122	0.635
13	0.112	0.114	0.140	0.199	0.159	0.138	0.234	0.114	0.117	0.138	0.169	0.219	0.497	0.204	0.161	0.048	0.456	0.038	0.027	0.024	0.023	0.028	0.520	0.132	0.203	0.036	0.126
14	0.112	0.114	0.140	0.199	0.234	0.138	0.159	0.041	0.117	0.138	0.169	0.176	0.055	0.068	0.161	0.180	0.095	0.169	0.129	0.137	0.134	0.153	0.171	0.132	0.190	0.122	0.126
15	0.045	0.041	0.028	0.065	0.036	0.031	0.036	0.041	0.041	0.031	0.038	0.038	0.055	0.068	0.032	0.048	0.095	0.038	0.027	0.024	0.023	0.028	0.035	0.027	0.055	0.036	0.042
16	0.045	0.041	0.028	0.065	0.036	0.031	0.036	0.041	0.041	0.031	0.038	0.038	0.055	0.068	0.032	0.048	0.095	0.038	0.027	0.024	0.023	0.028	0.035	0.027	0.055	0.036	0.042
17	0.112	0.114	0.140	0.199	0.159	0.138	0.159	0.114	0.117	0.138	0.169	0.176	0.193	0.204	0.161	0.180	0.231	0.169	0.129	0.137	0.134	0.153	0.171	0.132	0.190	0.122	0.126
18	0.045	0.041	0.028	0.065	0.234	0.256	0.234	0.041	0.041	0.031	0.038	0.038	0.055	0.068	0.032	0.048	0.095	0.038	0.027	0.024	0.023	0.028	0.035	0.027	0.055	0.036	0.042
19	0.045	0.041	0.028	0.065	0.036	0.031	0.036	0.041	0.041	0.031	0.038	0.038	0.055	0.068	0.032	0.048	0.095	0.038	0.027	0.024	0.023	0.028	0.035	0.027	0.055	0.036	0.042
20	0.112	0.041	0.549	0.194	0.159	0.138	0.159	0.114	0.117	0.138	0.169	0.038	0.193	0.068	0.032	0.508	0.095	0.169	0.027	0.024	0.023	0.153	0.035	0.132	0.055	0.036	0.126
21	0.045	0.041	0.028	0.065	0.036	0.031	0.036	0.041	0.041	0.031	0.038	0.038	0.055	0.068	0.032	0.048	0.095	0.038	0.027	0.024	0.023	0.028	0.035	0.027	0.203	0.273	0.267
22	0.045	0.114	0.028	0.065	0.036	0.031	0.036	0.041	0.041	0.031	0.038	0.038	0.055	0.189	0.032	0.048	0.161	0.169	0.129	0.024	0.023	0.153	0.035	0.132	0.055	0.122	0.126
23	0.112	0.114	0.140	0.199	0.159	0.138	0.159	0.114	0.117	0.138	0.169	0.038	0.055	0.068	0.032	0.048	0.095	0.038	0.027	0.024	0.023	0.028	0.035	0.027	0.055	0.036	0.042
24	0.045	0.041	0.028	0.194	0.234	0.256	0.036	0.281	0.277	0.256	0.224	0.219	0.055	0.189	0.233	0.508	0.161	0.224	0.027	0.259	0.263	0.241	0.223	0.263	0.203	0.036	0.126
25	0.045	0.041	0.028	0.065	0.036	0.031	0.036	0.041	0.041	0.031	0.038	0.038	0.055	0.068	0.032	0.048	0.095	0.038	0.027	0.024	0.023	0.028	0.035	0.027	0.055	0.036	0.042
26	0.112	0.041	0.028	0.489	0.036	0.031	0.036	0.041	0.041	0.031	0.038	0.038	0.055	0.068	0.032	0.048	0.456	0.038	0.027	0.024	0.023	0.028	0.035	0.027	0.055	0.036	0.042
27	0.112	0.114	0.140	0.199	0.159	0.138	0.159	0.114	0.117	0.138	0.169	0.176	0.193	0.204	0.161	0.180	0.231	0.169	0.129	0.137	0.134	0.153	0.171	0.132	0.190	0.122	0.126
28	0.112	0.041	0.028	0.065	0.234	0.031	0.036	0.041	0.041	0.256	0.520	0.176	0.201	0.189	0.032	0.048	0.095	0.169	0.129	0.024	0.023	0.028	0.035	0.027	0.499	0.122	0.126
29	0.112	0.114	0.028	0.194	0.159	0.138	0.159	0.114	0.117	0.256	0.224	0.038	0.201	0.485	0.233	0.048	0.456	0.169	0.027	0.137	0.134	0.536	0.171	0.027	0.203	0.036	0.126
30	0.045	0.041	0.028	0.065	0.036	0.031	0.036	0.041	0.041	0.031	0.038	0.038	0.055	0.485	0.233	0.048	0.095	0.224	0.027	0.024	0.023	0.028	0.035	0.027	0.055	0.036	0.042

* The first condition has been complied with because the threshold value for most items are ≤ 0.2

Table 4.20: The Threshold value for Part D

RESPONDENT	D - REQUIREMENT OF LEARNING TECHNOLOGY																								
	D1 - WHY NEEDS				D2 - STRUCTURE OF LEARNING TECHNOLOGY						D3 - TECHNIQUE OF LEARNING TECHNOLOGY					D4 - RATIONALE IMPLEMENTATION				D5 - ACCESSIBILITY CRITERIA					
	D11	D12	D13	D14	D21	D22	D23	D24	D25	D26	D31	D32	D33	D34	D35	D41	D42	D43	D44	D51	D52	D53	D54	D55	D56
1	0.148	0.127	0.156	0.188	0.206	0.153	0.114	0.138	0.146	0.143	0.212	0.178	0.183	0.201	0.130	0.096	0.125	0.115	0.155	0.129	0.120	0.123	0.112	0.137	0.100
2	0.148	0.127	0.156	0.188	0.206	0.153	0.114	0.138	0.146	0.143	0.181	0.215	0.212	0.055	0.032	0.057	0.038	0.046	0.039	0.041	0.041	0.043	0.045	0.040	0.059
3	0.026	0.032	0.032	0.055	0.069	0.025	0.041	0.031	0.034	0.030	0.076	0.047	0.043	0.055	0.032	0.057	0.038	0.046	0.039	0.857	0.041	0.043	0.045	0.040	0.059
4	0.247	0.032	0.237	0.235	0.187	0.242	0.041	0.256	0.034	0.030	0.181	0.047	0.043	0.201	0.032	0.057	0.038	0.046	0.039	0.041	0.274	0.269	0.282	0.255	0.293
5	0.026	0.032	0.032	0.055	0.069	0.025	0.041	0.031	0.034	0.030	0.076	0.047	0.043	0.055	0.032	0.057	0.038	0.046	0.039	0.041	0.041	0.043	0.045	0.040	0.059
6	0.148	0.032	0.156	0.188	0.069	0.025	0.041	0.138	0.034	0.030	0.476	0.509	0.212	0.055	0.032	0.096	0.125	0.115	0.155	0.041	0.041	0.123	0.112	0.137	0.100
7	0.148	0.127	0.156	0.188	0.069	0.153	0.114	0.138	0.146	0.143	0.212	0.178	0.183	0.055	0.130	0.096	0.125	0.115	0.155	0.129	0.120	0.123	0.045	0.040	0.100
8	0.026	0.127	0.156	0.188	0.069	0.153	0.114	0.138	0.146	0.143	0.181	0.178	0.043	0.193	0.130	0.096	0.125	0.115	0.155	0.041	0.120	0.123	0.112	0.137	0.100
9	0.148	0.127	0.032	0.188	0.483	0.242	0.041	0.031	0.247	0.030	0.181	0.215	0.212	0.800	0.264	0.057	0.038	0.115	0.238	0.129	0.120	0.123	0.112	0.137	0.100
10	0.148	0.127	0.156	0.539	0.206	0.153	0.114	0.138	0.146	0.143	0.212	0.178	0.183	0.193	0.130	0.096	0.561	0.115	0.155	0.129	0.120	0.123	0.112	0.137	0.100
11	0.026	0.032	0.032	0.539	0.483	0.153	0.041	0.138	0.034	0.030	0.212	0.178	0.043	0.055	0.130	0.096	0.268	0.570	0.530	0.129	0.120	0.123	0.112	0.547	0.100
12	0.148	0.127	0.156	0.188	0.069	0.025	0.114	0.138	0.146	0.143	0.212	0.178	0.043	0.055	0.130	0.096	0.125	0.115	0.039	0.129	0.120	0.123	0.112	0.137	0.100
13	0.026	0.032	0.032	0.055	0.069	0.025	0.041	0.031	0.034	0.030	0.076	0.047	0.043	0.055	0.032	0.057	0.038	0.046	0.039	0.041	0.041	0.043	0.045	0.040	0.059
14	0.148	0.127	0.156	0.188	0.206	0.153	0.114	0.138	0.146	0.143	0.076	0.047	0.043	0.055	0.032	0.096	0.125	0.115	0.155	0.129	0.120	0.123	0.112	0.137	0.100
15	0.148	0.127	0.156	0.188	0.206	0.153	0.114	0.138	0.146	0.143	0.212	0.178	0.183	0.193	0.130	0.096	0.125	0.115	0.155	0.129	0.120	0.123	0.112	0.137	0.100
16	0.026	0.032	0.032	0.055	0.069	0.025	0.041	0.031	0.034	0.030	0.076	0.047	0.043	0.055	0.032	0.057	0.038	0.046	0.039	0.041	0.041	0.043	0.045	0.040	0.059
17	0.026	0.032	0.032	0.055	0.069	0.025	0.041	0.031	0.034	0.030	0.076	0.047	0.043	0.055	0.032	0.057	0.038	0.046	0.039	0.041	0.041	0.043	0.045	0.040	0.059
18	0.026	0.032	0.032	0.055	0.069	0.025	0.114	0.031	0.146	0.143	0.212	0.178	0.183	0.193	0.130	0.096	0.125	0.115	0.155	0.129	0.041	0.123	0.045	0.137	0.100
19	0.247	0.268	0.237	0.055	0.069	0.025	0.041	0.031	0.034	0.030	0.181	0.215	0.212	0.201	0.264	0.057	0.038	0.046	0.039	0.264	0.274	0.269	0.045	0.040	0.293
20	0.026	0.032	0.032	0.055	0.069	0.242	0.041	0.031	0.146	0.250	0.076	0.047	0.043	0.201	0.032	0.096	0.125	0.115	0.155	0.041	0.041	0.043	0.045	0.040	0.100
21	0.247	0.268	0.237	0.235	0.187	0.242	0.281	0.256	0.247	0.250	0.181	0.215	0.212	0.201	0.264	0.299	0.268	0.278	0.238	0.264	0.274	0.269	0.282	0.255	0.293
22	0.247	0.268	0.237	0.235	0.187	0.242	0.281	0.256	0.247	0.250	0.181	0.215	0.212	0.201	0.264	0.299	0.268	0.278	0.238	0.264	0.274	0.269	0.282	0.255	0.293
23	0.026	0.032	0.032	0.055	0.069	0.025	0.041	0.031	0.034	0.030	0.076	0.047	0.043	0.055	0.032	0.057	0.038	0.115	0.039	0.129	0.120	0.043	0.112	0.040	0.100
24	0.026	0.032	0.032	0.055	0.069	0.025	0.041	0.031	0.034	0.030	0.076	0.047	0.043	0.055	0.032	0.057	0.125	0.046	0.155	0.129	0.120	0.123	0.112	0.137	0.100
25	0.247	0.127	0.032	0.055	0.069	0.025	0.114	0.138	0.146	0.143	0.076	0.047	0.043	0.055	0.130	0.096	0.125	0.115	0.155	0.129	0.120	0.123	0.112	0.137	0.100
26	0.247	0.268	0.032	0.188	0.069	0.153	0.114	0.138	0.146	0.143	0.476	0.178	0.183	0.193	0.130	0.096	0.125	0.115	0.530	0.129	0.120	0.123	0.112	0.137	0.100
27	0.026	0.032	0.237	0.235	0.187	0.025	0.281	0.256	0.540	0.545	0.076	0.047	0.212	0.055	0.264	0.057	0.038	0.278	0.039	0.041	0.274	0.561	0.045	0.547	0.293
28	0.026	0.032	0.532	0.055	0.069	0.025	0.041	0.256	0.247	0.030	0.076	0.047	0.212	0.055	0.130	0.057	0.038	0.046	0.238	0.041	0.041	0.043	0.282	0.137	0.100
29	0.148	0.127	0.156	0.188	0.483	0.242	0.114	0.256	0.247	0.250	0.181	0.509	0.043	0.193	0.130	0.096	0.125	0.115	0.155	0.129	0.120	0.123	0.112	0.137	0.100
30	0.026	0.032	0.032	2.145	0.069	0.025	0.041	0.031	0.034	0.030	0.076	0.047	0.043	0.055	0.032	0.057	0.038	0.046	0.039	0.041	0.041	0.043	0.045	0.040	0.059

* The first condition has been complied with because the threshold value for most items are ≤ 0.2

In this study, the first condition has been complied with because the threshold value for most items are ≤ 0.2, only the threshold value for some of the items are ≥ 0.2. However, the second condition has also been adhered to as the consensus from the group of experts has exceeded 75%. Value ($d_{m,n}$) for each ≤ 0.2 is 2042, hence (2042/2430) ×100% = 84%. Therefore, the result of the calculation for the amount of the threshold value exceeded 75% with a total of 84% for all items in Part B, Part C and Part D. This indicates the degree of agreement between the experts to reach a consensus is excellent. Therefore, the second round of the fuzzy Delphi is not required because the acquisition of data has complied with both conditions.

4.4.1.3 Findings: Study about Identifying the characteristics of students with DS (Part B)

The analysis shows the characteristics of students with DS. In Part B there are 29 items under discussion. Table 4.21 shows the scoring and defuzzification value for each item in Part B, while Table 4.22 shows the best scoring item.

Table 4.21: The Scoring Analysis for items in Part B

Score	B1(A) Characteristics of DS (Physical)	B1(B) Characteristics of DS (Emotional)	B1(C) Characteristics of DS (Learning Environment)	B2 Learning Needs of DS	B3 The Strengths of DS	B4 The Weaknesses of DS	B5 Opinion About Al-Quran Learning
1	B11 (0.842)	B17 (0.819)	B111 (0.707)	B24 (0.860)	B32 (0.846)	B44 (0.862)	B51 (0.937)
2	B14 (0.803)	B18 (0.800)	B110 (0.697)	B22 (0.857)	B33 (0.838)	B41 (0.767)	B53 (0.933)
3	B16 (0.776)	B19 (0.594)	B112 (0.630)	B25 (0.851)	B35 (0.762)	B42 (0.748)	B52 (0.930)
4	B12 / B15 (0.747)			B23 (0.744)	B31 (0.736)	B43 (0.710)	
5	B13 (0.673)			B21 (0.511)	B34 (0.703)		

Note: ( ) shows the defuzzification value.

Table 4.22: The Best Scoring Item in Part B.

Item Description **B: Characteristics of DS Students In Malaysia**	**Fuzzy evaluation**	**Defuzzification**	**Score**
B1(a): The physical characteristics of DS students **B11**: The same face shape. **B14**: Some DS students may have refractive errors.	(21.2, 26, 28.6) (19.6, 24.7, 28)	0.842 0.803	1&2
B1(b): The emotional characteristics of DS students **B17**: They are very friendly and cheerful. **B18**: They are very gregarious.	(20, 25.2, 28.5) (19.2, 24.6, 28.2)	0.819 0.800	1&2
B1(c): DS students' characteristics in a learning environment **B111**: They have difficulties in understanding something. **B110**: They have a short-term memory (easily forgotten).	(16.2, 21.6, 25.8) (15.7, 21.3, 25.7)	0.707 0.697	1&2
B2: What are the needs of DS students in a learning session? **B24**: Should show simple and lightweight knowledge. **B22**: Teachers always give encouragement (motivation) and praises them.	(21.4, 26.6, 29.4) (21.4, 26.5, 29.2)	0.860 0.857	1&2
B3: What are the strengths of DS students in a learning session? **B32**: Although they cannot speak well, but they were able to communicate with the people around them (in their own way). **B33**: Very easy to teach through pictures or models and sounds or songs or musical instruments.	(20.8, 26.1, 29.2) (20.6, 25.9, 28.9)	0.846 0.838	1&2
B4: What are the weaknesses of DS students in a learning session? **B44**: Teachers should control their emotions. **B41**: Their fine motor movements are very weak.	(21.8, 26.7, 29.1) (18, 23.6, 27.4)	0.862 0.767	1&2
B5: What do you think about the application of Al-Quran learning to the students with DS? **B51**: Very nice/good for Muslim students. **B53**: Light-hearted and blessed in life.	(25.2, 29.1, 30) (25, 29, 30)	0.937 0.933	1&2

Based on Table 4.21 and Table 4.22, 97% of the items achieved the highest expert consensus, which is over 0.60. Only one item was not agreed upon by the experts that is item B21: 'They cannot be in the study group because they can get emotionally disturbed if seeing a friend's group has been successful'; with a defuzzification value of 0.511. This shows that DS students can learn in a group and their emotions will not be affected when seeing their friends have completed the assignment. However, the majority of experts agreed and selected items B11, B14, B17, B18, A111, B110, B24, B22, B32, B33, B44, B41, B51 and B53 as the primary choices and should be placed as indispensable characteristics of DS students in order to provide teaching and learning tools for DS students.

The above analysis also shows that the DS students have farsightedness and their motor movement is very weak (B14 and B41), but they were able to communicate with others well (B32) and they were also very gregarious and loving (B17 and B18). However, they had difficulties in understanding and remembering things because they of their short-term memory which makes it very easy for them to forget previous lessons (B111 and B110). Therefore, they need to be provided with light and easy knowledge of learning, and the teacher has to always give encouragement and motivation to the DS students during the learning process (B24, B22 and B44). They are more likely to learn using pictures, models or musical instruments (B33). Learning Quran is also an excellent learning experience for DS students because it can lighten their hearts and make them calm (B51 and B53).

4.4.1.4 Findings: Study about Learning Methods for Students with DS (Part C)

The analysis shows the learning methods for students with DS. In Part C there are 27 items under discussion. Table 4.23 shows the scoring and defuzzification value for each item in Part C, while Table 4.24 shows the best scoring item.

Table 4.23: The scoring analysis for items in Part C

Score	C1 Methods Of Learning	C2 Strategies Of Learning	C3 Method Of Interaction Learning	C4 Suggestions Of Content Criteria
1	C11 (0.891)	C21 (0.890)	C34 (0.857)	C49 (0.884)
2	C12 (0.890)	C22 (0.888)	C31 (0.847)	C410 (0.881)
3	C16 (0.873)	C23 (0.873)	C35 (0.842)	C42 (0.880)
4	C13 (0.871)	C24 (0.851)	C32 (0.834)	C47 (0.878)
5	C15 / C17 (0.858)		C33 (0.827)	C44 (0.877)
6	C14 (0.830)		C36 (0.807)	C43 (0.874)
7				C45 (0.862)
8				C41 / C46 (0.850)
9				C48 (0.837)

Note: ( ) shows the defuzzification value.

Table 4.24: The Best Scoring Item in Part C.

Item Description **C: LEARNING METHODS FOR STUDENTS WITH DS**	**Fuzzy evaluation**	**Defuzzification**	**Score**
C1: What is the method of learning that is perceived as most suitable to DS students? **C11**: The needs of learning by pictures or models or form. **C12**: The best practice of learning is by imitating. **C16**: The use of learning aids that can be touched and seen. **C13**: The best practice of learning is matching.	(23, 27.6, 29.6) (22.8, 27.6, 29.7) (22.2, 27, 29.4) (22, 27, 29.4)	0.891 0.890 0.873 0.871	1 & 2 & 3 & 4
C2: What are the strategies of learning that is deemed suitable for students with DS? **C21**: Sings while making simple movements. **C22**: Always repeating the subject. **C23**: Learning style is relaxed and in an unpretentious mode.	(22.8, 27.6, 29.7) (22.8, 27.5, 29.6) (22.2, 27, 29.4)	0.890 0.888 0.873	1 & 2 & 3
C3: What is the interaction learning method that is deemed suitable for students with DS? **C34**: The use of clear and larger models. **C31**: Methods using the sense of touch (touch the model physically or through a touch screen). **C35**: The use of large fonts.	(21.4, 26.5, 29.2) (20.8, 26.2, 29.2) (20.8, 26.1, 28.9)	0.857 0.847 0.842	1 & 2 & 3
C4: What are the suggestions of content criteria for the learning apps that will be developed for DS students? **C49**: Apps should motivate the DS students to continue learning. **C410**: Apps that are free of violent properties (aggressiveness and pugnacity). **C42**: Apps that encourage students to be more interactive (provide immediate responses). **C47**: Apps should have music, graphics and images that are compatible with DS students. **C44**: Apps should have good repetition for contents of the syllabus.	(22.6, 27.4, 29.6) (22.8, 27.2, 29.3) (22.2, 27.3, 29.7) (22.2, 27.2, 29.6) (22, 27.2, 29.7)	0.884 0.881 0.880 0.878 0.877	1 & 2 & 3 & 4 & 5

Based on Table 4.23 and Table 4.24, all the 27 items in section C achieved the highest consensus of experts, which is over 0.60. This shows that all the items in section C was agreed upon by all the experts. However, the majority of experts agreed and selected items C11, C12, C16, C13, C21, C22, C23, C34, C31, C35, C49, C410, C42, C47 and C44 as primary learning methods in order to provide teaching and learning aid tools for students with DS.

The analysis above also shows that the majority of DS students really like pictures and models that can be touched and seen clearly as their learning aids (C11 and C16). The best practice of learning for DS students is the imitating and matching methods (C12 and C13). They also love to sing and perform simple movements such as dancing (C21), so their learning should be in a relaxed and unpretentious mode (C23). The learning syllabus also needs to be repeated constantly by the teacher so that students can better understand and remember it well (C22). Learning aids for DS students need to use large images and can be touched, for example the font size of the alphabets must be bigger and usage of the touch screen method (C34, C31 and C35). With regard to the application, it is necessary to motivate and encourage students to continue their education (C49) whereby they can always repeat a particular topic if they need to (C44). In addition, the application developed needs to be free of violence for DS students because they are very sensitive (C410). Besides that, this application should also encourage them to be more interactive (giving immediate responses) and incorporate elements of music, graphic and image that are compatible with DS students (C42 and C47).

4.4.1.5 Findings: Study about Requirements of Technology Learning in Assisting the Process of Teaching and Learning (Part D)

The analysis shows the requirements of technology learning in assisting the process of teaching and learning for students with DS. In Part D there are 25 items under discussion. Table 4.25 shows the scoring and defuzzification value for each item in Part D, while Table 4.26 shows the best scoring item.

Table 4.25: The scoring analysis for items in Part D

Score	D1 Why Needs	D2 Structure Of Learning Technology	D3 Technique Of Learning Technology	D4 Rationale Implementation	D5 Accessibility Criteria
1	D12 (0.881)	D23 (0.890)	D35 (0.879)	D41 (0.902)	D56 (0.899)
2	D11 (0.867)	D24 (0.873)	D32 (0.844)	D43 (0.888)	D54 (0.891)
3	D14 (0.862)	D26 (0.869)	D33 (0.842)	D42 (0.881)	D52 (0.886)
4	D13 (0.860)	D25 (0.867)	D34 (0.834)	D44 (0.860)	D53 (0.882)
5		D22 (0.863)	D31 (0.821)		D51 (0.878)
6		D21 (0.824)			D55 (0.872)

Note: ( ) shows the defuzzification value.

Table 4.26: The Best Scoring Item in Part D

Item Description **D: REQUIREMENTS OF LEARNING TECHNOLOGY IN ASSISTING THE PROCESS OF TEACHING AND LEARNING**	**Fuzzy evaluation**	**Defuzzification**	**Score**
D1: Why does someone need learning technology in their teaching and learning process? **D12**: Encourage students to love learning - a powerful attraction for learning. **D11**: Help students to understand faster and not get easily confused.	(22.4, 27.3, 29.6) (21.8, 26.8, 29.4)	0.881 0.867	1 & 2
D2: What is the structure (characteristics) which is essential for applying learning technology especially to assist the DS students? **D23**: Can be seen and touched. **D24**: Use of the voice of a cheerful child. **D26**: Apps that show fast response. **D25**: The movement of animation that is not too fast.	(22.8, 27.6, 29.7) (22.2, 27, 29.4) (22, 26.9, 29.3) (22, 26.8, 29.2)	0.890 0.873 0.869 0.867	1 & 2 & 3 & 4
D3: What form (technique) is deemed appropriate learning technology for DS students (in terms of colours, images, and other characteristics)? **D35**: Could provide motivation or words of praise in it. **D32**: Touch screen. **D33**: The simple animation.	(22.4, 27.2, 29.5) (21, 26.1, 28.9) (20.6, 26, 29.2)	0.879 0.844 0.842	1 & 2 & 3
D4: What is the rationale of the implementation of learning technology for students with Down syndrome? **D41**: DS students have an attraction to learn. **D43**: DS students are able to learn better than before. **D42**: DS students can quickly understand and not get easily discouraged.	(23.4, 28, 29.8) (23, 27.5, 29.4) (22.6, 27.3, 29.4)	0.902 0.888 0.881	1 & 2 & 3
D5: What are the suggestions of accessibility criteria for learning apps that will be developed for DS students? **D56**: Apps that provide greetings and tribute to the user. **D54**: Apps that provide a positive response to the answer. **D52**: Apps that are easy to understand. **D53**: Apps that contain images, graphics and sound.	(23.6, 27.8, 29.5) (23, 27.6, 29.6) (22.8, 27.4, 29.5) (22.8, 27.3, 29.3)	0.899 0.891 0.886 0.882	1 & 2 & 3 & 4

Based on Table 4.25 and Table 4.26, all the 25 items in section D has achieved the highest consensus of experts, which is over 0.60. This shows that all the items in section D was agreed upon by all the experts. However, the majority of experts agreed and selected items D12, D11, D23, D24, D26, D25, D35, D32, D33, D41, D43, D42, D56, D54, D52 and D53 as the primary requirements of learning technology in order to provide teaching and learning tools for students with DS.

The analysis above also shows that the majority of DS students requires learning technology in their teaching and learning process because it can encourage them to love learning and help them to understand faster, not get easily confused and discouraged (D12, D11 and D42). And subsequently, DS students are attracted to learn and they are able to learn better than before (D41and D43). Thus, the learning technology developed should be in touch screen mode, use of voice of a cheerful child, shows fast response, and use simple animation which should not be too fast (D23, D24, D26, D25, D32 and D33). In addition, it is also needed to provide motivation or words of praise for them (D35). To build a good learning technology tool as a learning aid for children with DS, these apps have to provide greetings and tribute to the user to create confidence, such as "Hello", "Congratulations, you won!", and "Yes! You succeeded" (D56). Additionally, it is also needed to provide a positive response to the answer even if the answer is not correct (D54). Apps also should be easy to understand with the use of images, graphics, and simple and appropriate sounds, especially in the delivery of important information (D52 and D53). In addition, in the analysis of part D, the item D31 that is survey for “The use of mobile technology” showed that it has a defuzzification value at 0.821, and has the highest consensus of experts, which is 93.3% of experts who agreed that mobile technology is one of the appropriate technology learning for DS students.

4.5 CALCULATION FOR CRONBACH'S ALPHA

Cronbach's alpha is a measurement used to assess the reliability, or internal consistency, of a set of scale or test items. The process of the calculation was discussed in Chapter 3. In this study, because there are too many items for measuring, it was concluded that Cronbach's alpha has to be calculated using the Factor Analysis process, which is the process of determining group of factors and splitting the test by factors. Therefore, in this study, the testing for the alpha was divided by certain parts, that is Section B for 29 items were split into 3 parts which are characteristics of DS, environment of learning, and opinion about Quran learning. Meanwhile, Section C for 27 items were split into 4 parts which are method of learning, strategies of learning, method of interaction learning and suggestion for content criteria. Subsequently, Section D for 25 items was split into 5 parts which are identifying the needs of technology learning, structure of learning technology, technique of learning technology, rationality of implementation and accessibility criteria. Table 4.27 below shows the Cronbach's alpha for each part. See APPENDIX D for more detail.

Table 4.27: Number of items by domain and Cronbach's Alpha

Elements	**Total of Item**	**Part**	**Number of Item (N)**	**α-Cronbach**
B: Characteristics of DS children in Malaysia	29 items	1: Characteristics of DS students	12	0.8672
		2: Environment Learning of DS students	14	0.6443
		3: Opinion about Quran Learning	3	0.9085
C: Learning Methods for Students with DS	27 items	1: Methods of Learning	7	0.8569
		2: Strategies of Learning	4	0.8678
		3: Methods of Interaction of Learning	6	0.8709
		4: Suggestions of Content Criteria	10	0.8856

Table 4.27: Number of items by domain and Cronbach's Alpha (continued)

Elements	**Total of Item**	**Part**	**Number of Item (N)**	**α-Cronbach**
D: Requirement of Learning Technology in Assisting Learning.	25 items	1: Identifying the needs of learning technology	4	0.7742
		2: Structure of learning technology	6	0.9057
		3: Technique of learning technology	5	0.8339
		4: Rationality of implementation	4	0.776
		5: The suggestions of accessibility criteria for learning apps	6	0.9009

Based on Table 4.27 above, the Cronbach's alpha for element B, part 1 is 0.8672, part 2 is 0.6443, and part 3 is 0.9085. While for element C, part 1 is 0.8569, part 2 is 0.8678, part 3 is 0.8709, and part 4 is 0.8856. Then, for element D, part 1 is 0.7742, part 2 is 0.9057, part 3 is 0.8339, part 4 is 0776, and part 5 is 0.9009. All of these Cronbach's alpha values in Table 4.27 above is acceptable. Therefore, the data obtained in this study can be concluded to have a level of acceptability and trustworthiness.

4.6 SUMMARY

Through this chapter, the data analysis and findings for the study were presented. Overall, the analysis of the findings of the study on identifying the characteristics of DS students, their environment of learning, and requirements of learning technology aids have contributed in terms of formulating the DS students' requirements in a learning environment. These factors are associated with the learning process and learning environment of children with DS. Researcher achieved RO1 in this chapter which is to

identify factors associated with the learning process and the learning environment of children with DS.

For the characteristics of DS students especially in Malaysia, the features are as follows:

- ✓ They have the same face shape.
- ✓ Some DS students may have refractive errors.
- ✓ They are very friendly and cheerful.
- ✓ They are very gregarious.
- ✓ Their fine motor movements are very weak.

In the learning environment of DS children:

- ✓ They have difficulties in understanding something.
- ✓ They have short-term memory (easily forgets).
- ✓ The content of the app should show simple and lightweight knowledge.
- ✓ Teachers always give encouragement (motivation) and praise them while being sensitive to their emotions.
- ✓ Although they cannot speak well, they were able to communicate with the people around them (in their own way).
- ✓ They are very easy to be taught through pictures or models and sounds or songs or musical instruments.
- ✓ The application of Al-Quran learning to students with DS is seen as very nice/good for Muslim students and as light-hearted and blessed in life.

The learning methods and requirements of learning technology (learning environment needs in terms of learning technology) for students with DS are as follows:

- ✓ They learn by pictures or models or forms, so apps must contain images, graphics and sounds; for example use of large fonts, voice recordings of a cheerful child and simple animation.
- ✓ The use of learning aids that can be touched and seen.
- ✓ The best practice of learning is the imitating and matching technique.
- ✓ Learning style is in a relaxed and unpretentious mode, and repetition in the subject.
- ✓ Apps should motivate the DS students to continue their learning and must be free of violent properties (aggressiveness and pugnacity), while encouraging students to love learning.
- ✓ Apps must help students to understand faster and not get easily confused; for example, apps must have a fast response to the answer and provide greetings and tribute to the user.

Based on the analysis of the items above, the conclusion of all 85 items reached the highest consensus point of value that shows the defuzzification value exceeded 0.60, with the level of expert agreement between "moderate agree", "agree" and "strongly agree". Although all the items reached the highest consensus, the chosen items in each section were chosen as priority and should be emphasized in accordance with the highest of the experts' consensus. Furthermore, based on the analysis, the experts agreed that mobile technology is one of the appropriate learning technology for teaching and learning session with DS students.

In addition, from the observation that was done in the Abahata (Al-Jabari) technique, it was seen that all DS students who participated in this programme were very happy to recite the Quran with the Abahata (Al-Jabari) method. This covered RO2, which is to

obtain the appropriate method to recite the Quran (targeted to recognise ***hijaiyah*** letters) for children with DS. However, the weaknesses in their movement ability hindered them from performing well in the clapping technique that was introduced by the the Abahata (Al-Jabari) method. Therefore, to make learning the Al-Quran by the Abahata (Al-Jabari) method more meaningful to DS students, the illustration of the '***Kompang'*** instrument in computerized learning tools will have a huge impact if adopted. These teaching aids will provide a great impetus to the DS students to continue their learning well and successfully.

Based on the characteristics of the learning environment of DS children and M-Learning characteristic framework by Martin and Ertzberger (2013), the model of DSERL was indicated as proposed in Chapter 5.

CHAPTER 5: MODEL AND SYSTEM DESIGN

5.1 INTRODUCTION

This chapter explains the result of this study which is a user requirement model to assist the app developer in developing the appropriate app for DS children in the teaching and learning process. This model is called the DSERL. This proposed DSERL model provides the elements of the individual strengths of DS children in learning environments. Hence, it has to be considered as user requirements to be used by software developers in designing and implementing learning app for DS children.

5.2 MODEL OVERVIEW

The DSERL model aims to serve as a support and provide better learning app for DS children in the teaching and learning session. The proposed DSERL model consists of elements that are derived from the M-learning characteristics framework by Martin and Ertzberger (2013), and Learning environment and Learning style of DS as the outcome of the preliminary study. The goal of this characteristic framework is to improve student learning and development. It focuses on the element of engaging, authentic and informal learning mode that captures the learner character to the domain of learning environment and serves as a powerful tool to organise learning experience for students. The summary of M-learning characteristics framework by Martin and Ertzberger (2013) was shown in Table 2.7 in Section 2.7.2, in Chapter 2.

From the summary of M-learning characteristics framework by Martin and Ertzberger (2013) in Table 2.7, the combination of the learning environment and learning style from the preliminary study that was covered in Chapter 4, is shown in Table 5.1 below.

Table 5.1: Justification of M-Learning characteristics framework by Martin and Ertzberger (2013) in learning environment of DS.

Characteristic	Learning Environment of DS
Engaging	To cater to short term memory (Cognitive): - **Through the elements they love, i.e. large alphabets, child voices and simple animations.** - **Elements of learning that can be touched and seen.** - **Parents' and teacher's creativity to compile the knowledge for DS students.** - **Teacher/parent encouragement.**
Authentic	To maintain student's attention to the context: - **Encourage students to love learning and stabilization of the emotions.** - **Use the illusory element and no element of violence.** - **Lightweight knowledge and simple topic knowledge.** - **Showing appreciation such as greetings and tribute.** - **Learning by imitating and matching technique.** - **Ability of mobile technologies to provide portability tools.**
Informal	Informal learning activities: - **Relaxing learning mode and learning by picture/model and sound.** - **Repeating the subject/topic.** - **Ability of mobile technologies to provide ease in context of use.**

As a collaboration with the elements of engaging, authentic, and informal learning from the characteristic framework by Martin and Ertzberger (2013), the proposed model of DSERL is indicated in Figure 5.1. The DSERL model used in app development for DS children is composed of the following elements:

1. Cognitive: Engaging students in the context of learning. The act of beginning to capture the attention of learners that must be taken care of by the developer to provide better learning app for DS. While, learning environment of DS is strengthens memorization and learning for DS using ears and eyes.
2. Affective: Approaching technique using user motivation and activities that the learners love to do (authentic learning activities).
3. Representation style: Approaching learning style that is accepted by the learners.
4. Learning style: Style of learning that is suitable for the learners (informal learning activities).

Figure 5.1 shown below depicts the proposed DSERL model and the description of each element is given in the sections below.

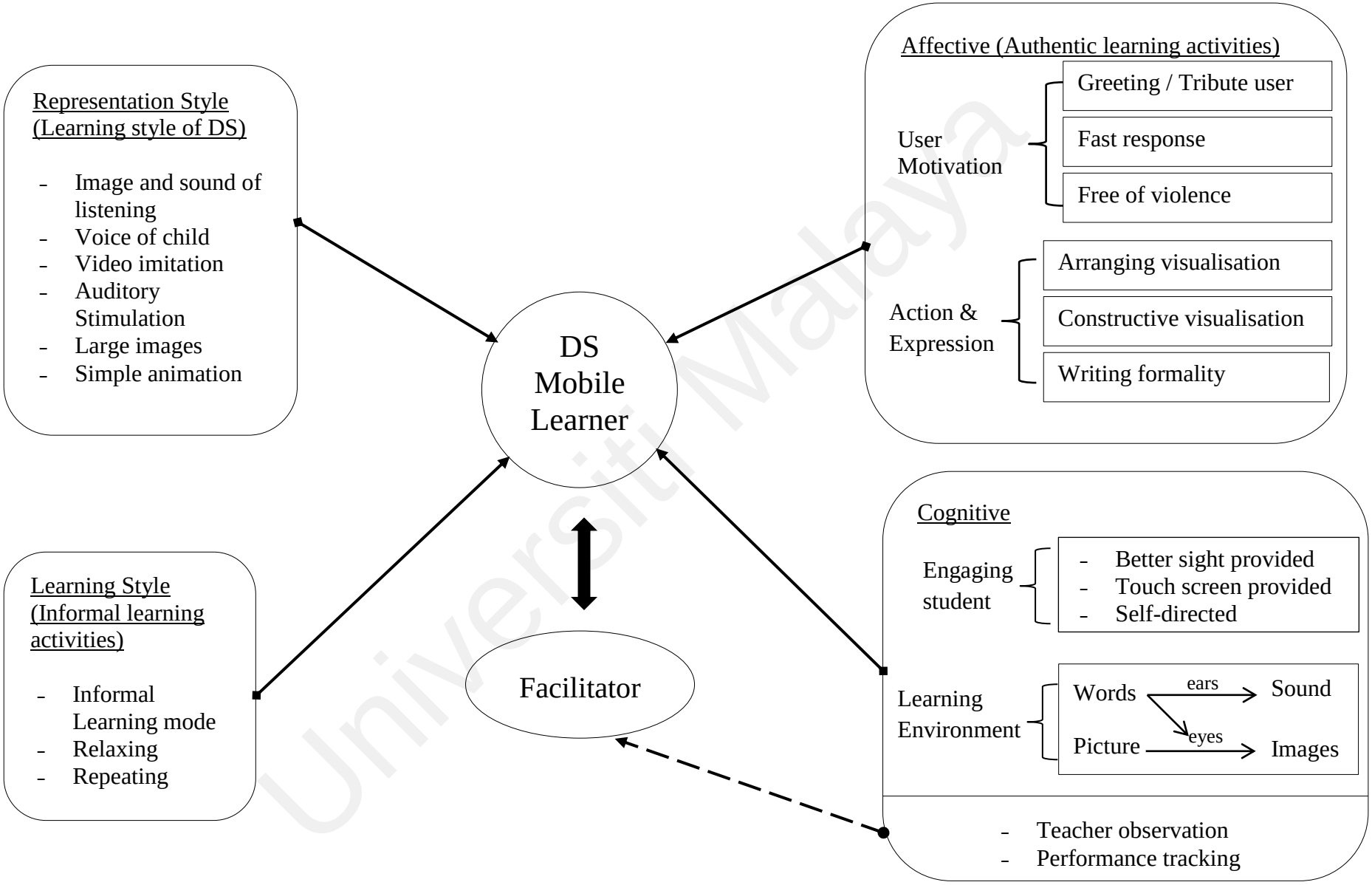


Figure 5.1: The DSERL model

The proposed DSERL model was used in the development of learning app to increase the performance of children with DS in learning *hijaiyah* letters. Thus, the description below elaborates the user requirements for the suitable and appropriate app for DS.

5.2.1 Down syndrome Mobile Learner

Mobile learner refers to those with DS. All elements of the learning environment and learning technique refer to the learning needs of DS to ensure that their learning needs are known and prioritized.

5.2.2 Facilitator

The facilitator refers to parents, teachers and the people that are directly involved with learning activities for those with DS. The facilitator is functioning as a facilitator for the continuity of a learning activity because those with DS need much support from others in their learning environment.

5.2.3 Cognitive Elements

Cognitive elements refer to the knowledge domain that needs to be done so that DS students can become better learners. The knowledge domain referenced by this model is memorization. From the findings in chapter 4, the process of remembering for those with DS is very weak. Therefore, this model proposes techniques that can be used by developers to hone the memory of DS students in order to remember their learning better. It is known that psychomotor especially the gross motor skills for those with DS are weak, so this model suggests that the senses used to remember activities are by using ears and eyes, in which both of these senses will see the picture/image being displayed and hear the sound of the letter being pronounced. Using this technique, the process of remembering for those with DS will improve.

While, elemental engagement refers to the requirements that the app needed so that DS students enjoy and are more comfortable using these app. Better sight provided means the eyesight view. This element is important because according to studies, most DS students are unable to see exactly or straight to the point because of their squinting eyes condition. Therefore, it is recommended that the creation of app for DS students should include a wide-ranging view and be shown one by one so that they can see the learning object well. The touch screen provided means they can touch the object virtually in the app and the response of the app against the touch screen should be naturally present. This is because if the app have a slow response, the learners will become tired and end up bored in continuing their learning. Other than that, self-directed elements refer to the use of app independently in which DS students are able to carry out their learning activities on their own while being monitored by teachers, parents and others. Therefore, it is recommended that the creation of the app should also consider the elements of teacher observation by using the elements suggested in the representation style so that facilitator monitoring becomes more conducive.

5.2.4 Affective Elements

Affective elements is an approach that developers can use in developing the learning app and it is acceptable to those with DS. For those with DS, the motivational element is important especially at the start of learning because when they are motivated, learning will become easier and teachers will be more than happy to teach them. From the findings in Chapter 4, this motivational technique for those with DS is important to ensure that these DS learners can continue their learning well. The app that are to be built need to show elements of greeting because this is the way for the DS learners to get closer to the app and immerse themselves in a learning environment based on the app. Besides that, developers also need to show tribute to users if they can build or

create an activity well. The element of fast response is also necessary because DS students get easily tired of something and does not like to wait, so app need to show fast response and attract students to the next learning. These app also need to be free of elements of violence because the DS students have weaknesses in their internal condition. These violent elements will cause them to stay away from the learning environment and they will not be motivated.

Action and expression also refers to activities that can provide solid support for these DS students to continue with their learning. The technique of arranging, constructing and writing is suggested by this model because in the findings of Chapter 4, the matching technique is the most effective technique for DS students to remember their learning. Therefore, learning app for those with DS should contain these elements to make sure that learning app become the best in terms of quality.

5.2.5 Representation Style Elements

Representation style elements refer to the appropriate learning elements or techniques for DS students. According to the study, DS students are very fond of learning through pictures or models and sound. Therefore, it is recommended that the app to be built should emphasize elements such as image and sound. The sounds need not be too noisy and sound recording is better if it uses a child's voice. From the studies conducted in Chapter 4, the best practice of learning is the imitation technique that is most preferred by DS students, thus app are recommended to contain elements such as video recordings so that students can emulate learning or imitate the action in the videos. Simulation methods are also necessary in the development of app for DS students in which animation through simulation will be able to attract DS students to continue with

their learning. For example, developers can use or insert virtual guitar or piano instruments into app to make their app more interactive.

5.2.6 Learning Style Elements

Learning style elements refer to the appropriate learning style of DS students. According to the study in Chapter 4, simple and relaxed learning styles are well-liked by DS students where they do not have to follow certain procedures for learning. An informal learning mode is a highly-suited learning mode practiced in learning app for students with DS because they do not need to be bound by the learning rule chain and are free to choose which parts they would like to explore in the learning app. A repeating learning style is also recommended so that students can repeat the learning according to their needs in order to reinforce their memory of that lesson. Therefore, it is recommended that the app to be built should contain a control button to enable students or teachers to repeat the learning topic well.

5.3 SYSTEM DESIGN

System design is the process of finding the architecture, components, modules, interfaces and data for a system to satisfy the specified requirements. Hence, it is described as the application of systems theory to product development. The UML is the standard language in analysis and design.

5.3.1 User class

The main user class is the DS children. This is the most important user class. The user interface design is geared towards serving the user. Members of this user class are from six-year-old DS children to adults who have basic computer literacy skills (including

using the touch screen pad). There is no strict educational requirement for this user class besides a basic understanding of the two-dimension coordinate system. Because of DS students' needs, the guidance from others (like teacher or parent) is also possible; another user class is the facilitators. People from this user class have experience in using the app tools and knowledge in educational training on DS students. This user class is not as important as the main user. This user class is mostly interested in controlling the main user when using the app.

5.3.2 Functional Requirement

The functional requirement for this prototype describes what the app must do. This includes the processes and the interfaces with the user (DS children). Functional requirements for this prototype depends on the system features that include the following:

5.3.2.1 System features: System has a graphical user interface

The system has an easy-to-use graphical user interface that supports mobile touch screen functions. This feature is essential for the system.

Use Case 1:

User starts the application	
Description	This is a system initiation process.
Pre-condition	The system has been correctly installed in the mobile window.
Post-condition	The system runs and shows a graphical interface to the user. The user is able to use the system.
Normal Sequence	The user activates the application. The system starts and shows the graphical interface to the user. The user is able to use the system.
Exceptions	Condition: There is a problem with loading the app.
	Action: The system informs the user about the error.
	Ending: The program is terminated.

Functional Requirement:

GUI	The system uses a graphical interface to display data to the user.
GUI.touchcreeninput	The system can be used fully with a touch screen.

5.3.2.2 System features: The app end on a predefined condition

The app have an ending condition, defined in the corresponding app definition. When this condition is carried out, the app will end. The system then proceeds to the user. This feature has a high priority.

Use Case 2:

The app ends on a pre-defined condition.	
Description	When the finishing condition of the app is achieved, the app will end.
Pre-condition	The app is being played.
Post-condition	The current app is finished and cannot be played anymore.
Normal Sequence	When the user makes a move to click the end button, the system tells the user about the end of the app and the user cannot use the app anymore.
Exceptions	If the ending condition has not been defined, the app may never end.

Functional Requirement:

App.End	The will end on a pre-defined condition.

Functional requirements also capture the intended behaviour of the system. This behaviour may be expressed as services, tasks or functions the system is required to perform. For this project, the system shall implement the following user function:

- Users can learn the song rhythm from the application (Level-1). The application should display all the scripts of the song together with the singing version.

- Users can learn letters (***hijaiyah***) from the application (Level-2). The application should display all the letters together with the pronunciations version.
- Users can learn the pronunciation of a word through “Video Imitate” (Level-3).
- Users can know the letter and practice to pronounce it in the ***kompang*** version.
- Users can draw or write the letters through “Writing” (Level-4).
- Users can play a “recognizing puzzle” consisting of the letters.

5.3.3 External Interface Requirement

5.3.3.1 User Interface

The entire user interface is designed following common guidelines in the usability document. They use one main window for the actual app environment.

5.3.3.2 Hardware Interface

The system functions on a mobile that has a screen for output and touch screen for input.

5.3.3.3 Software Interface

The system must be executable in Android and the graphical user interface supported by Android OS or Java, XML or EXE file (mobile environment).

5.3.4 Non-Functional Requirement

Non-Functional Requirements will mainly contain the quality attributes of the system.

Non Functional Requirement	Type	Requirement Description
Usability	Process	The application should be easily understood by the user (user-friendly).
Modifiability	Process	The application should be easily modifiable by the developer at anytime and anywhere.
Accessibility	Process	The system can be accessed by the user at anytime and anywhere by various people.
Reliability	Data/ Information	The knowledge content should be in accordance with national standards.
Maintainability	Process	The ease with which the system can be maintained in order to: i) isolate defects or their cause; ii) correct defects or their cause; iii) meet new requirements; iv) make future maintenance easier; or v) cope with a changed environment.
Correctness	Data/ Information	The correctness of the answers of the user and Abahata (Al-jabari) teaching method is very important in this system.

5.3.5 Use Case Diagram

Use case diagrams provide an overview of the usage requirements for a system. For the actual development, use cases provide significantly more value because it describes the appropriate requirements.

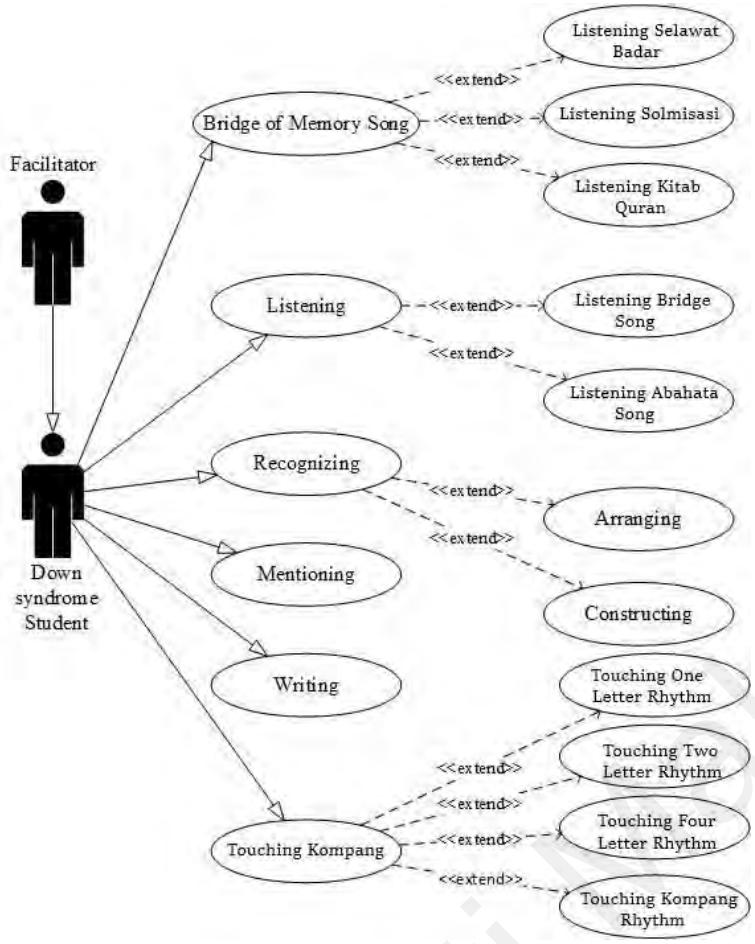


Figure 5.2: Use Case Diagram

Figure 5.2 shows the use case diagram for the Abahata learning app, with actor description and use case description in Tables 5.2 and Table 5.3.

Table 5.2: Actors Description

Actor	**Description**
Down syndrome Student	The user who is using the app.
Facilitator	The user who controls the User when they are using the app.

Table 5.3: Use Cases Description

Use case	**Description**
Bridge of Memory Song	When the user presses this button, the second menu that shows three buttons appears, that are Selawat Badar button, Solmisasi button and Kitab Qur'an button.
Listening	When the user presses this button, the second menu that shows two buttons appears, that are Memory Bridge button and ABAHATA button.
Recognizing	When the user presses this button, the second menu that shows two buttons appears, that are Arranging button and Construction button.
Mentioning	When the user presses this button, the video imitate scene appears when user presses the square flat button and the user can press the circle flat button to continue the learning.
Writing	When the user presses this button, the learning writing scene appears and the user can press the square flat button to continue learning. User can learn how to write when the small circle dots is touched.
Touching *Kompang*	When the user presses this button, the second menu that shows four buttons appears, that are One Letter button, Two Letter button, Four Letter button and Kompang Rhythm button.
Listening *Selawat Badar*	When the user presses this button, the gist word for Selawat Badar's lyric scene appears and the user can press the play button to listen to the song.
Listening *Solmisasi*	When the user presses this button, the gist word for Solmisasi's lyric scene appears and the user can press the play button to listen to the song.
Listening *Kitab* Quran	When the user presses this button, the gist word for Kitab Quran's lyric scene appears and the user can press the play button to listen to the song.
Listening Bridge Song	When the user presses this button, the whole letter of Abahata scene appears and the user can press the square flat letter button to listen to the Bridge song.
Listening Abahata Song	When the user presses this button, the four letter of Abahata scene appears and the user can press the square flat letter button to listen to the Abahata song.
Arranging	When the user presses this button, the arranging play scene appears and the user can start dragging the pieces to play and learn. When the user drags the pieces correctly, the sound of the letter will be played to help the user get the right pronunciation.

Table 5.3: Use Cases Description (continued)

Use case	**Description**
Constructing	When the user presses this button, the constructing play scene appears and the user can start dragging the pieces to play and learn. When the user drags the pieces correctly, the sound of letter will be played to help the user get the right pronunciation.
Touching One Letter Rhythm	When the user presses this button, the ***kompang*** with the one letter sound scene appears and the user can start to press the ***kompang*** to play and learn. The user can press the square flat button to continue learning and can choose either to listen to the voice recording of 'ustaz' or 'child'.
Touching Two Letter Rhythm	When the user presses this button, the ***kompang*** with the two letter sound scene appears and the user can start to press the ***kompang*** to play and learn. The user can press the square flat button to continue learning and can choose either to listen to the voice recording of 'ustaz' or 'child'.
Touching Four Letter Rhythm	When the user presses this button, the ***kompang*** with the four letter sound scene appears and the user can start to press the ***kompang*** to play and learn. This kompang scene appears with four letters simultaneously but the user can only press one letter at a time. The sound of the letter will be played when the user presses the letter. The user can press the circle flat button to continue learning.
Touching ***Kompang*** Rhythm	When the user presses this button, the ***kompang*** with the ***kompang's*** sound scene appears and the user can start to press the ***kompang*** to play and learn.

5.3.6 Activity Diagram

Activity diagrams are graphical representations of workflows of stepwise activities and actions with support for choice, iteration and concurrency. Activity diagrams can be used to describe the operational step-by-step workflow of components in a system. An activity diagram shows the overall flow of control. Arrows run from the start towards the end and represent the order in which activities happen. Generally, rounded

rectangles represent activities; a black circle represents the start (initial state) of the workflow while an encircled black circle represents the end (final state).

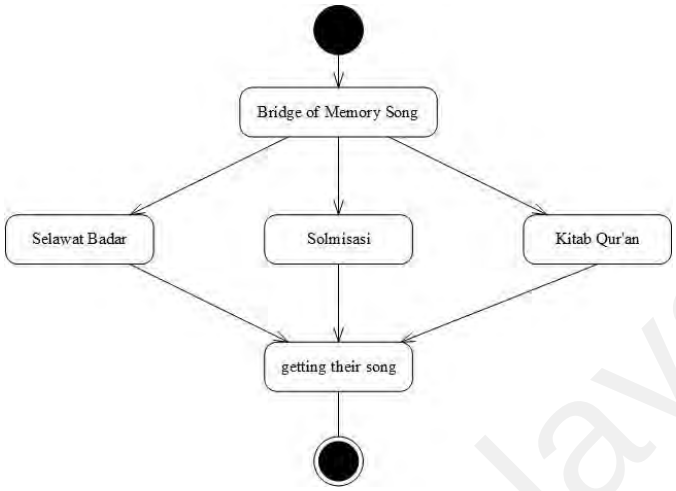


Figure 5.3: Activity Diagram for Bridge of Memory Song module

Figure 5.3 shows the activity diagram for the Bridge of Memory Song. It includes three sub-workflow components that are ***Selawat Badar***, ***Solimisasi*** and ***Kitab*** Quran. This sub-workflow contains the button that is used to upload the song.

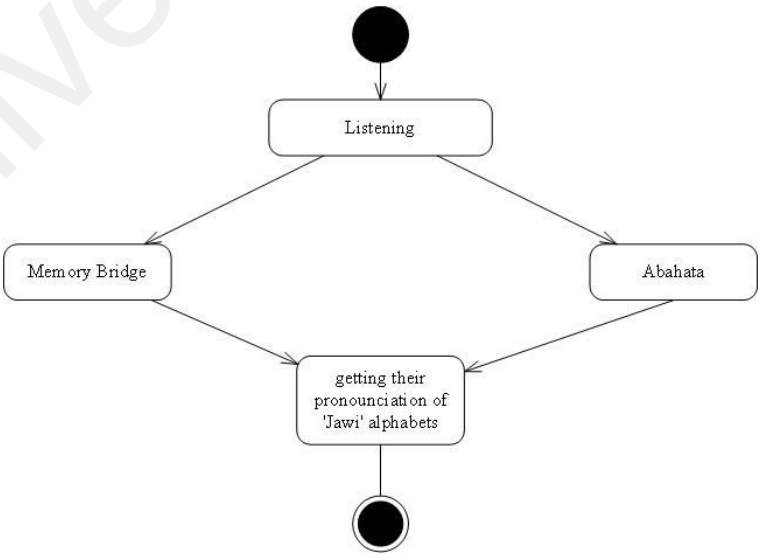


Figure 5.4: Activity Diagram for Listening module

Figure 5.4 shows the activity diagram for the Listening module. It includes two sub-workflow components that are Memory Bridge and *Abahata*. This sub-workflow contains the image and button that are used to upload the voice of pronunciation of '*Jawi'* alphabets.

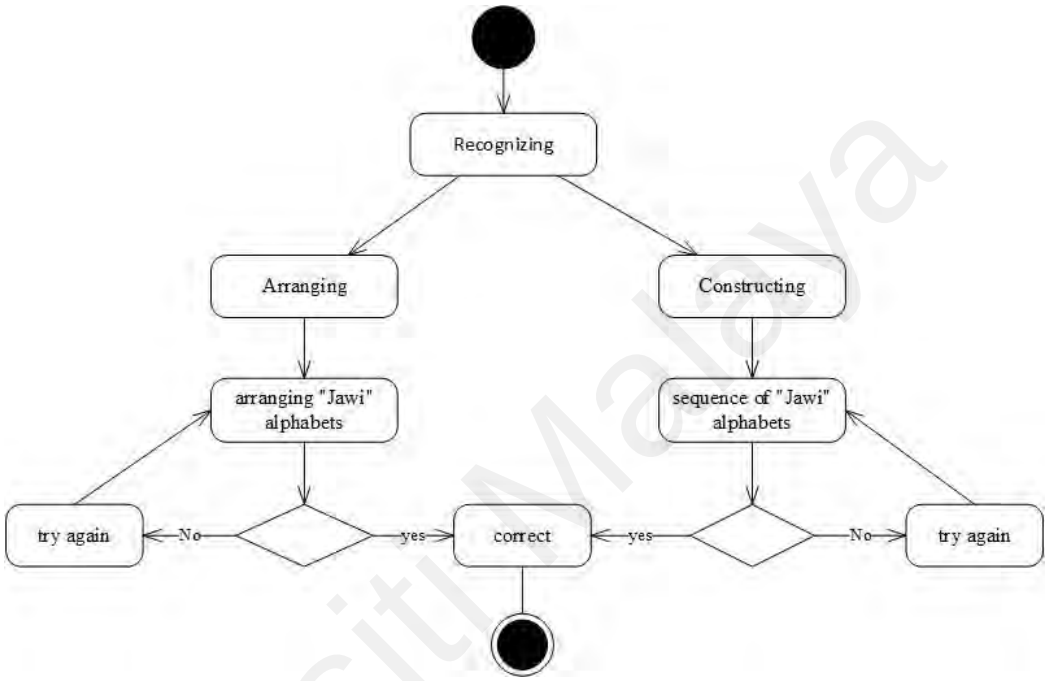


Figure 5.5: Activity Diagram for the Recognizing module

Figure 5.5 shows the activity diagram for the Recognizing module. It includes two sub-workflow components that are arranging and constructing. This sub-workflow contains the image that the user can drag to play and learn.

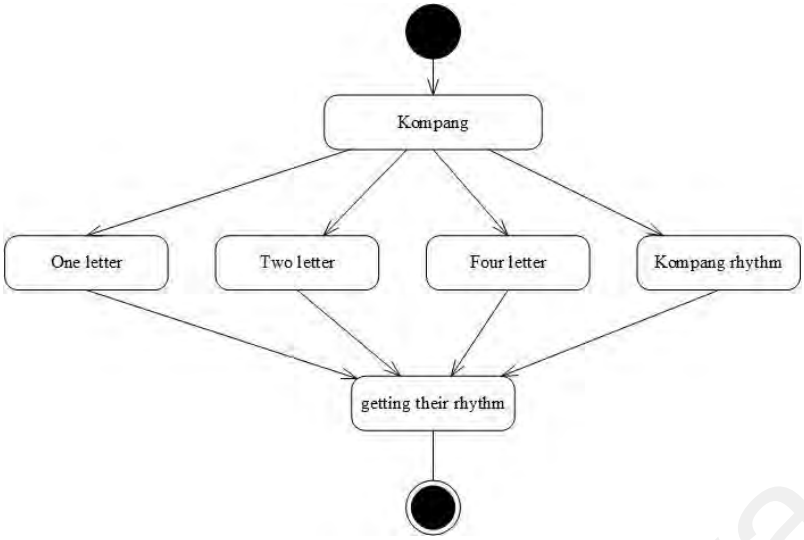


Figure 5.6: Activity Diagram for the *Kompang* module

Figure 5.6 shows the activity diagram for the *Kompang* module. It includes four sub-workflow components that are One Letter, Two Letter, Four Letter and *Kompang* Rhythm. This sub-workflow contains the image of the *Kompang* that the user can press to upload the sound of *Abahata* song and the *Kompang's* sound.

5.3.7 Data Flow Diagram

This diagram shows the main functions of the system as a process. It also shows the tasks that are carried out and how they are performed. It also describes the interaction between the components.

Level 0:

A Level 0 data flow diagram documents the system's boundaries by highlighting its sources and destinations. It shows the main functions in the system as a process. Figure 5.7 shows the main function in the Faqeh Abahata app that includes the Bridge of Memory Song module, Listening module, Recognizing module, Mentioning module, Writing module and *Kompang* module.

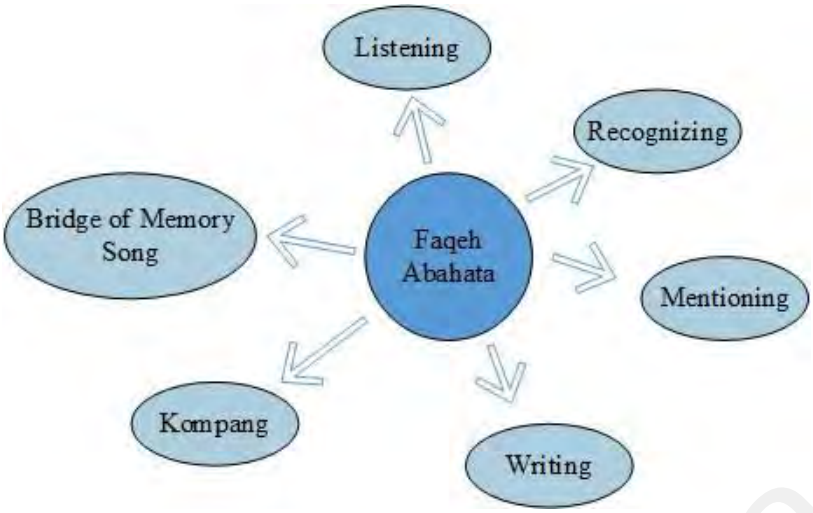


Figure 5.7: Level 0 Data Flow Diagram

Level 1:

A level 1 data flow diagram shows the system's primary processes, data stores, sources, and destinations linked by data flows. Figure 5.8 shows the data flows of each module in the Faqeh Abahata app.

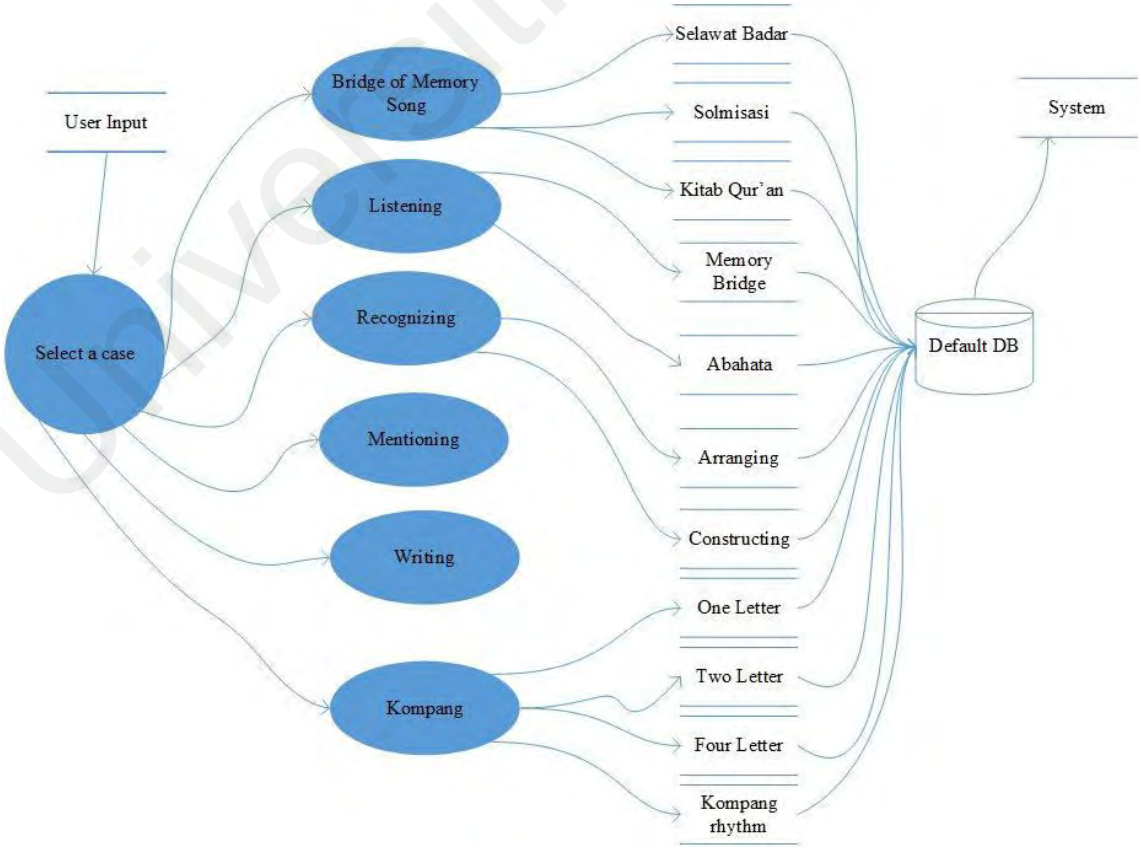


Figure 5.8: Level 1 Data Flow Diagram

Figure 5.7 and Figure 5.8 shows the data flow diagrams for the Faqeh Abahata learning app. In these figures, the components and the relationship between the components while using the app environment are shown.

5.4 PROTOTYPE DESIGN

The software learning system prototype was designed in line with the proposed model which comprises user requirement components that were highlighted. The prototype learning system called the Faqeh Abahata learning app prototype is meant for teaching *hijaiyah* letters to children with DS. The prototype learning system development was based on the components of the model identified as explained in section 5.2 above. In addition, the tool for the development process and sketching menu for the prototype is provided below.

5.4.1 App Development Tools

5.4.1.1 Mobile Applications and Operating System (Android)

The operating system (OS) that handles smartphones, tablets and other digital mobile devices is called a mobile operating system. It is a data set or program that manages all hardware and optimizes the effectiveness of software applications in the device. Mobile operating systems can be seen in smartphones powered by Android, iOS, BlackBerry OS, Windows Mobile, Palm WebOS, Symbian, Maemo and many more. From the literature review, the best operating system most widely used is the Android smartphone's touch screen. Android is an OS mobile that is based on the open source Linux developed by Google. It is an optional software as it is a low-cost, customizable, lightweight OS for high-tech devices without developing one from scratch.

The Android runtime layer holds the Dalvik Virtual Machine (DVM) and the core libraries (such as Java or IO). Most of the functionalities available in Android are provided via the core libraries. The DVM is an interpreter for the byte code that has been transformed from Java byte code to Dalvik byte code. Dalvik itself is compiled to native code whereas the core libraries are written in Java, thus interpreted by Dalvik. Models in the Application Model layer are written in Java and provide abstractions of the underlying native libraries and Dalvik capabilities to applications. The application model houses the API interface. In this layer, the activity manager governs the application life cycle. The content providers enable applications to either access data from other applications or to share their own data. The resource manager provides access to non-code resources (such as graphics), while the notification manager enables applications to display custom alerts.

The structure of an Android application is based on four different components, which are: Activity, Service, Broadcast Receiver and Content Provider. An application does not necessarily consist of all four of these components, but presents a graphical user interface that at least has an Activity. Components can interact with other components of the same or a different application via intents. Applications can start other applications or specific components of other applications by sending Intent. These intents contain, among other things, the name of the desired executed action. The Intent Manager resolves incoming intents and starts the proper application or component. The reception of an Intent can be filtered by an application. Services and broadcast receivers allow applications to perform jobs in the background and provide additional functionality to other components. Broadcast receivers can be triggered by events and only run a short period of time whereas a service may run for a long time. The compiled code of the application components and additional resources like libraries, images and

other necessary data is packed into a single.apk file that forms the executable Android application.

5.4.1.2 AndroidManifest.xml

All Android Dalvik applications need to have a XML document in the application's root directory called AndroidManifest.xml. This document is used by various facilities in the system to obtain administrative and organizational information about the application. In the manifest file, predefined element types are allowed to specify among other things the application name, the components of the application, permissions, needed libraries and filters for intents and broadcasts. During development, the manifest file holds the control information for instrumentation support.

5.4.1.3 Activities

An Activity is a single screen of an application like a browser window or a settings page. It contains the visual elements that present data (like an image) or allow user interaction (like a button). Each application can have multiple activities whereas the transition between the different activities is initiated via intents. All activities are subclasses from android.app. Activity and their life cycle is controlled by the onXYZ () methods. This concept is needed by the Android's way of handling multitasking and helps deal with low memory situations. The main functions are onCreate(), onDestroy(), onPause(), onResume() and onRestart(). The function used in this application are: onCreate(): The initial method to set up an Activity.

5.4.1.4 Intents, Intent Filters and Receivers

Intent is an asynchronously sent message object including the message that should be transported. Android utilizes different hooks in the application components to deliver

the intents. For an activity, the onNewIntent() method is called, while at a service the onBind() method is called. Broadcast actions can be announced using Context.sendBroadcast() or similar methods. Android sends the Intent to the onReceive() method of all matching registered receivers. Intents can be filtered by an application to specify which intents can be processed by the application's components. The list of filters is set in the application's manifest file, thus Android can determine the allowed intents before starting an application.

5.4.1.5 Content provider

The data storage and retrieval in Android applications are done via content providers. These providers can also be used to share data between multiple applications, given that the involved applications own the correct permissions to access the data. Android already has default providers for e.g. images, videos, contacts and settings which can be found in the android.provider package. Applications only access content providers via a ContentResolver, never directly. If an application wants to store data that does not have to be shared, it can use a local SQLiteDataBase.

5.4.2 Sketching Menu

The following are the sketching menu for the prototype. There are fifteen screens altogether where it has similarities in the sketching description for item colour, text and font.

5.4.2.1 Main menu

Figure 5.9 shows the main menu or the early screen of the app. Table 5.4 provides the description of the items in the sketching.

Screen description: These are early screens of the main menu that will be seen by the user.

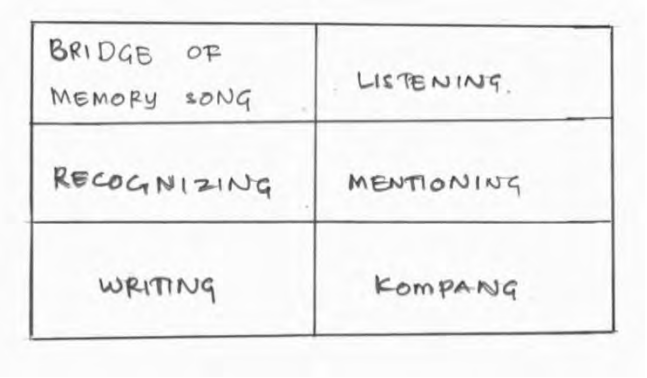


Figure 5.9: The early screen (main menu) of sketching

Table 5.4: Main menu sketching description

Item	**Description**
Narration	In this early screen, the user will see six buttons, which the user can then choose.
User Interaction	This screen is an early interaction with the player. The user can press the button to start learning with the app.
Placement	Buttons: There are six buttons that will appear so that the user can optionally choose to start the learning.
Colours	There are probably more colours included because of the background.
Text	There is the Title text on the button and background's screen.
Font	From the first screen, the title uses large font and the information uses normal font.
Animation	Animation comes from the image on the button.
Links from screen(s)	For the first screen, there is no link from any other screens.
Links to screen(s)	The user may choose the button to continue the lesson in the app.

5.4.2.2 Bridge of Memory Song menu

Figure 5.10 shows the second menu of the Bridge of Memory Song. Table 5.5 provides the description of the items in the sketching.

Screen description: These are the screens of the menu that will be seen by the user after they press the Bridge Of Memory Song's button.

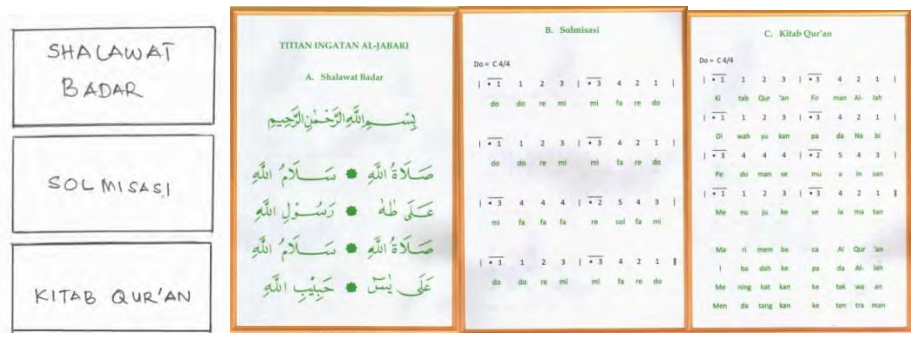


Figure 5.10: The first and second menu of Bridge of Memory Song

Table 5.5: Bridge of Memory Song menu sketching description

Item	**Description**
Narration	In the first screen, the user will see three buttons, after which the user can choose what they want; if they choose *Shalawat Badar* button then *Shalawat Badar* screen menu will open, if they choose *Solmisasi* button then *Solmisasi* screen menu will open, and if they choose *Kitab* Quran button then *Kitab* Quran screen menu will open.
User Interaction	These screens are from the second interaction with the player if they choose the Bridge of Memory Song button frmo the main menu. The user can press the chosen button and continue with the Play button to start listening to the song with the app.
Placement	Buttons: There are three buttons that will appear in the first screen so that the user can optionally choose to go to the second screen to start listening to the song.
Colours	There are probably more colours included because of the background.
Text	There is the title text on the button, background's screen and text of the lyric.
Font	From the first screen, the title uses large font and the information uses normal font.
Animation	Animation comes from the image on the button.
Links from screen(s)	For the first screen, there is the link from the button in the main menu screen. The second screen is linked from the first screen.
Links to screen(s)	In the first screen, the user may choose the button to continue the lesson in the second screen.

5.4.2.3 Listening menu

Figure 5.11 shows the second menu of the Listening module. Table 5.6 provides the description of the items in the sketching.

Screen description: This is the screen of the menu that will be seen by the user after they press the Listening button.

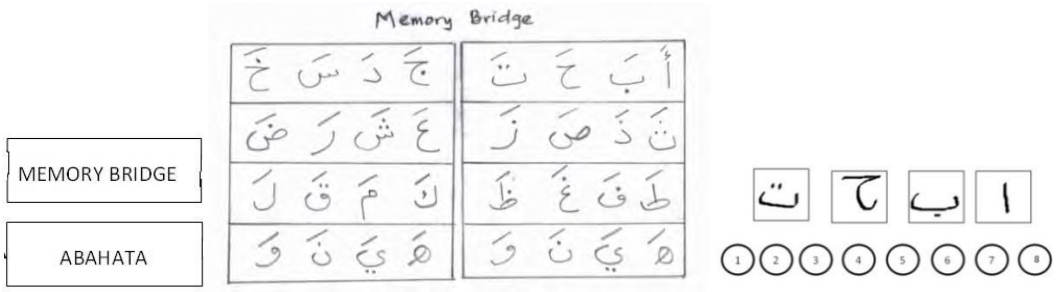


Figure 5.11: The first and second screen of Listening menu

Table 5.6: Listening menu sketching description

Item	**Description**
Narration	In the first screen, the user will see two buttons, which the user can choose. If they choose the Memory Bridge button then the Memory Bridge second screen menu will open and the user will see eight boxes, which the user can choose and press the box to listen to the pronunciation; if they choose the Abahata button then the Abahata second screen menu will open and the user will press the box and circle button to listen to the pronunciation and continue the lesson.
User Interaction	These screens are the second interaction with the player when they choose the Listening button in the Main menu. The user can press the chosen button to go to the second screen to start listening to the pronunciation with the app.
Placement	Buttons: There are two buttons that will appear so that the user can optionally choose to start listening to the pronunciation and to start learning.
Colours	There are probably more colours included because of the background.
Text	There is a title text on the button and background's screen.
Font	From the first screen, the title and the information uses normal font. Texts also come from the ***hijaiyah*** letter font.
Animation	Animation comes from the image on the button.
Links from screen(s)	For the first screen, there is the link from the button in the main menu screen. The second screen is linked from the first screen.
Links to screen(s)	In the first screen, the user can choose the button to continue the lesson in the second screen. Then, the user may choose the box and circle the flat button to continue the lesson in the app.

5.4.2.4 Recognizing Menu

Figure 5.12 shows the second menu of the Recognizing module. Table 5.7 provides the description of the items in the sketching.

Screen description: These are the screens of the menu that will be seen by the user after they press the Recognizing button.

Figure 5.12: The Recognizing menu followed by Arranging and Constructing screen

Table 5.7: The Recognizing, Arranging and Constructing screen menu sketching description

Item	**Description**
Narration	In the first screen, the user will see two buttons, which the user can choose the lesson; if they choose the Arranging button, and then the Arranging screen will appear, and if they choose the Constructing button, then the Constructing screen will appear.
User Interaction	These screens are the second interaction with the player if they choose the Recognizing button from the main menu. The user can press the button to start to play the arranging and constructing game with the app.
Placement	Buttons: There are two buttons that will appear so that the user can optionally choose to start the learning. In the second screen, the 'New' flat button and circle flat button are to continue the lesson.
Colours	There are probably more colours included because of the background.
Text	There is a title text on the button and background's screen.
Font	From the first screen, the title and the information uses normal font. The texts also come from the ***hijaiyah*** letter font.
Animation	Animation comes from the image in the Arranging and Constructing screen when users start dragging the image.
Links from screen(s)	For the first screen, there is a link from the button in the main menu screen. The second screen is linked from the first screen.
Links to screen(s)	In the first screen, the user can choose the button to continue the lesson in the second screen. Then, the user may choose the circle flat button to continue the lesson in the app.

5.4.2.5 Mentioning Menu

Figure 5.13 shows the second menu of the Mentioning Menu. Table 5.8 provides the description of the items in the sketching.

Screen description: This is the screen of the menu that will be seen by the user after they press the Mentioning button.

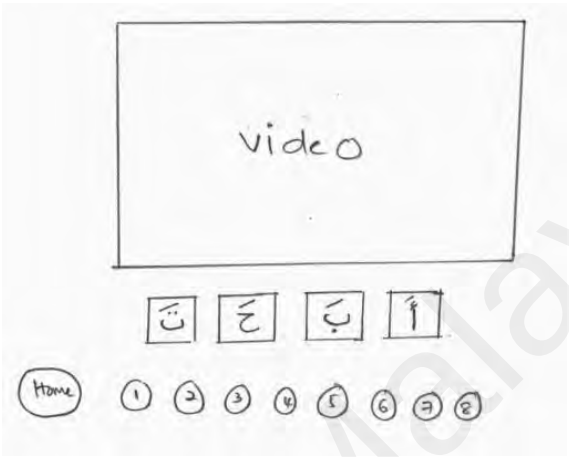


Figure 5.13: The Mentioning screen menu

Table 5.8: Mentioning menu sketching description

Item	**Description**
Narration	In this screen, the user will see eight circle flat buttons, which the user can choose and press the flat button to listen and see the imitating video of the the Abahata pronunciations.
User Interaction	This screen is an interaction with the player when they choose the Mentioning button in the Main menu. The user can press the flat circle button to start listening and imitating the video of the Abahata pronunciations with the app.
Placement	Buttons: There are eight flat circle buttons that will appear so that the user can optionally choose to start the learning.
Colours	There are probably more colours included because of the background.
Text	There is a title text on the button and background's screen.
Font	The title and the information uses normal font. The texts also come from the ***hijaiyah*** letter font.
Animation	Animation comes from the image on the button.
Links from screen(s)	This screen is linked from the first screen at the Main menu.
Links to screen(s)	In this screen, the user may choose the flat circle button to continue the lesson in the app.

5.4.2.6 Writing Menu

Figure 5.14 shows the second menu of the Writing Menu. Table 5.9 provides the description of the items in the sketching.

Screen description: This is the screen of the menu that will be seen by the user after they press the Writing button.

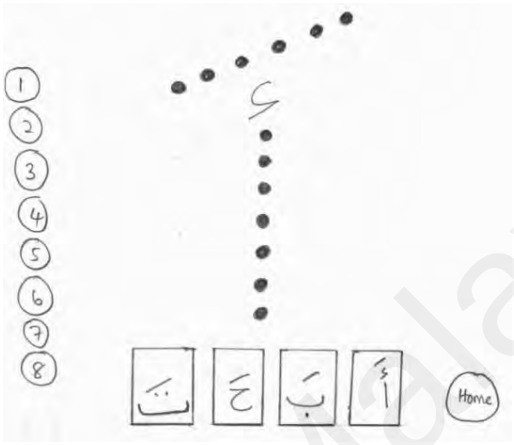


Figure 5.14: The Writing screen menu

Table 5.9: Writing menu sketching description

Item	**Description**
Narration	In this screen, the user will see eight circle flat buttons, which the user can choose and press the flat button to start writing the Abahata letter.
User Interaction	This screen interacts with the player when they choose the Writing button in the Main menu. The user can press the circle and square flat buttons to start the learning session on writing Abahata letters with the app.
Placement	Buttons: There are eight flat circle buttons and square flat buttons that will appear so that the user can optionally choose to start the learning.
Colours	There are probably more colours included because of the background.
Text	There is a title text on the button and background's screen.
Font	In this screen, the title and the information uses normal font. The texts also come from the ***hijaiyah*** letter font.
Animation	Animation comes from the image on the button and press on the dots activity.
Links from screen(s)	This screen is linked from the first screen at the Main menu.
Links to screen(s)	In this screen, the user may choose the circle and square flat button to continue the lesson in the app.

5.4.2.7 Kompang Menu

Figure 5.15 shows the second menu of the Kompang Menu. Table 5.10 provides the description of the items in the sketching.

Screen description: These are screens of the menu that will be seen by the user after they press the Kompang button.

Figure 5.15: The Kompang menu and One letter, Two letter and Kompang rhythm screen

Table 5.10: The Kompang, One letter, Two letter and Kompang rhythm screen menu sketching description

Item	**Description**
Narration	In the first screen, the user will see three buttons, which they can choose to continue the lesson. If they choose the One Letter button, then the One letter screen will appear, if they choose the Two Letter button, then the Two letter screen will appear, and if they choose the Kompang Rhythm button, then the *Kompang* rhythm screen will appear.
User Interaction	The first screen is the second interaction with the player if they choose the Kompang button at the main menu. Then the user can press the chosen button to start playing the illustration of ***kompang*** with the app.
Placement	Buttons: There are three buttons that will appear so that the user can optionally choose to start the learning. The flat button is to allow the user to continue the lesson.
Colours	There are probably more colours included because of the background.
Text	There is a title text on the button and background's screen.
Font	In this screen, the title and the information uses normal font. Texts also come from the ***hijaiyah*** letter font.
Animation	Animation comes from the image on the ***kompang*** screen when users start pressing the image of the ***kompang***.
Links from screen(s)	For the first screen, there is a link from the button in the main menu screen. The second screen is linked from the button on the first screen.
Links to screen(s)	In the first screen, the user can choose the button to continue their lesson in the second screen. Then, the user may choose the flat button to continue the lesson in the app.

5.5 Summary

This chapter discusses the model and design of the app development process as a design solution for this study. In the first section, the detailed DSERL model was discussed and in the second section the system design was discussed; it started by identifying the project scope and requirements needed in this development process, including the analysis design of the app. Next, this chapter discusses the user interface design (sketching) of the app.

In conclusion, the DSERL model is a model that emphasizes DS characteristics in a learning environment. This study used the DSERL model to develop the learning app that is appropriate with the learning strengths of children with DS. Therefore, this achieves the third research objective (RO3) that is to propose a model to assist students with DS in a learning process that uses their learning strengths.

CHAPTER 6: PROTOTYPE IMPLEMENTATION AND EVALUATION

6.1 INTRODUCTION

This chapter discusses the construction of the app learning prototype, its implementation process and testing. It also presents user acceptance tests.

Prototype implementation is a process of developing a prototype based on the scratch low fidelity design that was discussed in Chapter 5. The prototype learning system that has been discussed is called the Faqeh Abahata learning app for teaching the Abahata (Al-Jabari) method of reciting the Quran (the first book that introduced the pronunciation of ***hijaiyah*** letters) to children with DS. The prototype learning app development was based on the components of the model of DSERL. The prototype covers only Book 1 of the Abahata (Al-Jabari) method because the development of all the books in the Abahata (Al-Jabari) method will take a long time to complete. Therefore, as a prototype, only one of the books was developed to meet the objective and to cover the scope of this study.

This chapter also presents the user acceptance test which reflects the prototype implementation and testing processes. This process also concerns the installation of the prototype that was tested in the testing process. The testing process is often reflected as verification and validation of the app development process. This part was done to make sure that the app developer built the right product according to the specification and the quality of the implementation. Testing and debugging are important processes used in prototype development to discover any defect or bug present in the product. A successful testing discovers all errors in the prototype and demonstrates that the functions of the prototype work according to the specification.

6.2 ADAPTATION OF DSERL MODEL IN FAQEH ABAHATA APP

The DSERL model was applied for the design and development of the Faqeh Abahata learning app. As mentioned earlier, this model consists of several elements which are very important to ensure the learning objectives are achieved while using the Faqeh Abahata learning app. A detailed explanation about each element and its association with the app are discussed as below:

6.2.1 Cognitive: Students learning environment and the ability of learners

In the preliminary study, as explained before, to strengthen the memory among DS children is by using the ears and eyes. In association with the Faqeh Abahata learning app, it emphasizes on recognizing and memorising '*Jawi'* alphabets through sounds and images. By adapting sound and audio, the learning process could be made more enjoyable and appealing. In the Faqeh Abahata learning app, audios and sounds are often used for the pronunciations of '*Jawi'* alphabets and in the Abahata (Al-Jabari) learning technique, songs are used in learning ***hijahiyah*** letters ('*Jawi'* alphabets).

While, the ability of learners refers to the degree of freedom for the learner to learn according to their preference and at their own pace. This is very important as it could actualize an active learning and self-study environment that must be taken care of by the developer to provide better learning apps for DS children. In the Faqeh Abahata learning app, this aspect is highlighted in the main menu and submain menu page where the user can select which category they would prefer before proceeding to the next step. The students also can touch the button given in order to start the learning.

6.2.2 Affective: Approaching technique

The approaching technique uses user motivation and activity/attitude that the learners love to do it. In the preliminary study as explained before, it is defined that DS children are very friendly, cheerful and gregarious; and also the best practice of learning is to practice the imitating and matching techniques. The Faqeh Abahata learning app emphasizes on reward and words of encouragement. Reward is very important in order to keep students motivated and steadfast in learning. In the Faqeh Abhata app, every task that has been completed correctly will be rewarded with words of praise such as "GOOD JOB" and words of encouragement will be displayed even if an error is made. Meanwhile, the activity that DS students love involves the visualization concept. In association with the Faqeh Abahata learning app, it emphasizes on arranging and the constructive game is applied because game attributes are important in order to attract and engage students so that they can sit still and learn, especially for those with learning disabilities such as children with DS. The Faqeh Abahata app also applied the writing module that was one of the core learning process in the Abahata (Al-Jabari) learning technique in which students can trace the dotted lines to learn how to write 'Jawi' alphabets and it also includes the alphabet pronunciations.

6.2.3 Representation style: Approaching learning style

A representation style of learning is meant to support the learning process and a student's engagement especially for those with learning disabilities such as children with DS. There are several aspects that have been applied and highlighted in the Faqeh Abahata learning app that are accepted by the DS learners, i.e. video imitation, image and sounds, and kompang stimulation. Videos, images and sounds are from a recorded video and voice of a child; simple animation and smooth movements were used.

6.2.4 Learning style: Style of learning

In the preliminary study as explained before, the learning style that is suitable for DS learners are a relaxed and informal learning mode with continuous repetition of the subject. In the Faqeh Abahata learning app, this aspect is highlighted in a simple module of learning how to pronounce '*Jawi'* alphabets according to the Abahata (Al-Jabari) learning technique. This app also provides a repeated button to allow the user to repeat the learning module. For example, in the Abahata lesson page for the listening category, the sound of '*Jawi'* alphabets (***hijaiyah*** letters) will be produced every time the users click/touch the letter's button. Meanwhile, in the Abahata lesson page for arranging and constructive category, the users can click/touch the 'Again' button to repeat the learning session. Furthermore, the ***hijaiyah*** Al-Jabari kompang rhythm will be played once the users click/touch the ***kompang*** image to listen to the '*Jawi'* alphabets sound.

Table 6.1 summarizes the role of each component and also the association with the Faqeh Abahata learning app.

Table 6.1: Association components with Faqeh Abahata Learning App

No	Components of model	Description of the Component	Association with Faqeh Abahata Learning App
1	Cognitive	Students learning technique that strengthens the memory of learning for DS using the ears and eyes The ability of learners that must be taken care of by developers to provide better learning apps for DS	• Education: Learning the Quran • It emphasizes on recognizing and memorizing '*Jawi'* alphabets through sounds and images. Learning environments: Gives degree of freedom to learn at own space. The content of app: Should show simple and lightweight knowledge. Requirements: Learning aids that can be touched and seen
2	Affective	Approaching technique using user motivation and activity/attitude that the learners love to do	Musical (sound): By adopting sounds and audio of a child. Reward: Important to keep them motivated and persistent in learning sessions. Game Visualization: Puzzle like, Drag and Drop, Touch and Listen, Touch and Watch
3	Representation style	Approaching a learning style that is accepted by the learners	Apply a few interactive activities such as matching, drag and drop, imitating video, touching and displaying video (***kompang*** stimulation)
4	Learning style	Style of learning that is suitable for the learners	Relaxed and informal learning: App provides the button that the users can control to learn by themselves Repetition: Help learners in memorizing and getting familiar with the knowledge

6.3 PROTOTYPE COMPONENTS

The Faqeh Abahata learning app has been successfully designed and implemented to give DS children the opportunity to learn the Quran better. The Faqeh Abahata app was developed using Android Studio which Android runtime layer holds the DVM and the

core libraries (such as Java or IO). Figure 6.1 shows the structure components of the Faqeh Abahata learning app. The main component in this structure is the DVM application that was used to control the whole application (user input) of the apps.

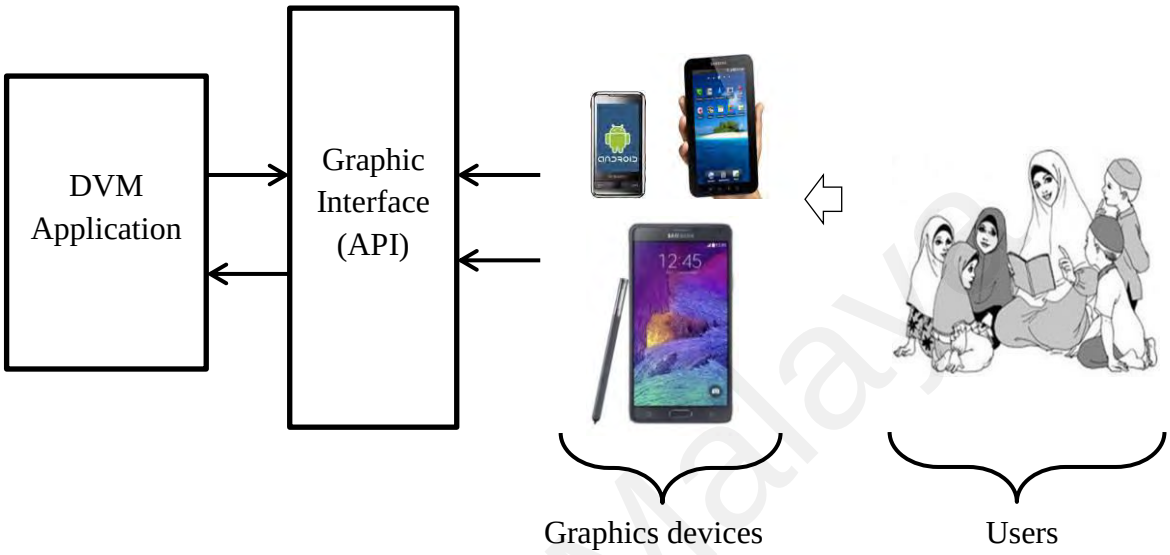


Figure 6.1: Structure components of Faqeh Abahata learning apps.

6.3.1 Users

Users refer to the DS students and teachers who have the authority to control the learning environment of the app. Students and teachers can control all the graphics devices as the input for the app machine application.

6.3.2 Graphics Devices

Graphics devices were used to keep the input from the users. These components were also associated with the graphics interface to control the user input (user's reflection) with the app.

6.3.3 Graphics Interface

Graphics interface contains all modules whether they are controlled by the player or by the machine applications. All these modules, including the background work in the Android runtime layer that holds the DVM and the core libraries (such as Java or IO) and API with graphical user interface are supported by AndroidManifest.xml (mobile environment).

6.3.4 Dalvik Virtual Machine (DVM) Application

DVM application is the important component that controls the input of the user and controls the entire plot (module) in the app. This application is connected to the graphics interface component by XML document in the application's root directory called AndroidManifest.xml.

6.4 DVM IMPLEMENTATION (PSEUDO CODE EXAMPLES)

One of the important components in the Faqeh Abahata learning app is the DVM Application. Figures 6.2 to 6.5 show the pseudo code for this component. See APPENDIX E for the complete view of the selected part of the source code. Figure 6.2 illustrates the loading action and back action for each level. There is a condition statement to update the app.

```
import { platformBrowserDynamic } from '@angular/platform-browser-dynamic';
import { AppModule } from './app.module';
platformBrowserDynamic().bootstrapModule(AppModule);
.
.
.
@NgModule({
	declarations: [
		MyApp,
		HomePage,
		Memory,
		Listening,
		Recognizing,
		Mentioning,
		Writing,
		Kompang,
		Arranging,
		Construction,
		Kompangone,
		Kompangtwo,
		Kompangfour,
		Listeningmain,
		Abahata,
		Writing2,
		ShalawatPage,
		SolmisasiPage,
		KitabQuranPage,
		WritingMainPage,
		WritingAlifPage,
		KompangSoundPage,
		WritingTaPage
	],
	imports: [
		BrowserModule,
		IonicModule.forRoot(MyApp, {
			pageTransition: 'fade'
		}),
		FaqehHeaderModule
	],
.
.
.
export class AppModule {
	constructor(config: Config) {
		config.setTransition('fade', FadeTansition);
	}
}
```

Figure 6.2: Algorithms for loading button.

Figure 6.3 illustrates the action of the arranging part. This algorithm loads all the user action to the next level until the game is complete.

```
import { Component, Renderer, ElementRef } from '@angular/core';
import { NavController, NavParams } from 'ionic-angular';
import { LetterProvider } from '../../providers/letter/letter';

@Component({selector: 'page-arranging',
        templateUrl: 'arranging.html',
})
…….
                this.letterList = [
                letters.getLetters(['ta', 'ha', 'ba', 'a', 'kho', 'sa', 'da', 'ja']),
                letters.getLetters(['za', 'so', 'tza', 'tsa', 'tho', 'ro', 'sha', 'aa']),
                letters.getLetters(['tzo', 'gho', 'fa', 'to', 'la', 'qo', 'ma', 'ka']),
                letters.getLetters(['wa2', 'na2', 'ya2', 'haa2', 'wa', 'na', 'ya', 'haa']),
                ];
                this.finishedSound = [
                        'assets/sound/abahatajadasakho.mp3',
                        'assets/sound/sazashozaasharodo.mp3',
                        'assets/sound/thofaghozokamakola.mp3',
                        'assets/sound/hayanawahayanawa.mp3',
                ]
                this.randomPiece = this.letterList[this.currentPage];
        }
……..
onPanEnd(event: any): void {
                this.renderer.setElementStyle( this.currentElem, 'z-index', '');
                if ( this.doneGame ){
                        setTimeout( () => {
                                let sound = new Audio(this.finishedSound[this.currentPage]);
                                sound.play();
                                this.doneArrange = true;
                        }, 1000);
                }
                if (this.donePan[this.currentElem.id] === false) {
                this.renderer.setElementStyle( this.currentElem, 'left', this.tempX + 'px');
                this.renderer.setElementStyle( this.currentElem, 'top', this.tempY + 'px')
                }
        }
…….
        ionViewWillLeave(){
                if ( typeof this.sound !== 'undefined' && this.sound !== null){
                        this.sound.pause();
                }
        }
}
```

Figure 6.3: Algorithms arranging user action.

Figure 6.4 illustrates the user action of the writing part. This algorithm loads all the user action to the next user action until the writing is complete. Meanwhile, Figure 6.5 illustrates the user action of the kompang part. This algorithm loads all the user action to the next user action until the beats of the kompang is complete.

```
@Component({selector: 'page-writing-alif',
        templateUrl: 'writing-alif.html',})
export class WritingAlifPage {
        @ViewChild('writingCanvas') canvas: ElementRef;
        @ViewChild('writingCanvasHolder') canvasHolder: ElementRef;
        canvasElement; canvasOffset; fbCanvas;      ctx;dotOption = {radius: 12,fill:
'#777',};
        dots: any[];currentDot = 0;clickedDot = null;
        sound;dotsList;cur;letter;
        constructor(public navCtrl: NavController, public navParams: NavParams,
letterProvider: LetterProvider ) {this.letter = letterProvider.getLetter('a');    }
……
        startDotting(i){
                this.currentDot = 0;
                this.cur = i;
                this.dots = this.dotsList[this.cur];
                this.clickedDot = this.dots[0];
                this.ctx.beginPath();
                this.ctx.arc(this.clickedDot.x,
                this.clickedDot.y, this.dotOption.radius + 1, 0, 2 * Math.PI);
                this.ctx.fillStyle = '#ffa300';
                this.ctx.fill();
                this.ctx.closePath();    }
…….
        playSound() {  this.sound = new Audio(this.letter.audio);
                this.sound.play();
                this.sound.addEventListener("ended", endedHandler);
                function endedHandler() }
        drawLine(toDot) {
                this.ctx.beginPath();
                this.ctx.arc(toDot.x, toDot.y, this.dotOption.radius + 1, 0, 2 *
Math.PI);
                this.ctx.fillStyle = '#ffa300';
                this.ctx.fill();
                this.ctx.closePath();
                this.ctx.beginPath();
                this.ctx.moveTo(this.clickedDot.x, this.clickedDot.y);
                this.ctx.lineTo(toDot.x, toDot.y);
                this.ctx.lineWidth = 8;
                this.ctx.strokeStyle = '#ffa300';
                this.ctx.stroke();
                this.ctx.closePath();
        }}
```

Figure 6.4: Algorithms for writing user action.

```
import { Component } from '@angular/core';
import { NavController, NavParams } from 'ionic-angular';
@Component({          selector: 'page-kompangtwo',
        templateUrl: 'kompangtwo.html', })
 export class Kompangtwo {
        singleArr = [
        {       letter: 'hata',
                image: 'hata.png',
                audioList: ['hata1.wav',          'hata2.wav','hata3.wav',
                'hata4.wav','hata5.wav','hata6.wav','hata7.wav',
                'hata8.wav','hata9.wav','hata10.wav','hata11.wav',
                'hata12.wav','hata13.wav','hata14.wav',
                'hata15.wav', 'hata16.wav',],   },
 ……..
        queueSound(){
                let audioList = this.singleArr[this.current].audioList;
                this.queue.push(audioList[this.ii]);
                this.ii++;
                if ( this.ii > this.singleArr[this.current].audioList.length-1 ){
                        this.ii = 0;}
                if( this.sound == null ){
                        this.sI = 0;
                        this.sound = new Audio('assets/listening/' +
this.audioVersion +'/' +
                                this.queue[this.sI]);
                        this.sound.play();
                        this.sound.addEventListener("ended",
this.endedHandler.bind(this));
                }}
        endedHandler() {
                this.sI++;
                if ( typeof this.queue[this.sI] === 'undefined' || this.queue[this.sI]
=== null ){
                        this.queue = [];
                        this.sound = null;
                        return;          }
                this.sound = new Audio('assets/listening/'+ this.audioVersion +'/' +
                   this.queue[this.sI]);
                this.sound.play();
                this.sound.addEventListener("ended", this.endedHandler.bind(this));
        }
        ionViewDidLoad() {  }
        ionViewWillLeave(){
                if ( typeof this.sound !== 'undefined' && this.sound !== null){
                        this.sound.pause();

                } } }
```

Figure 6.5: Algorithm for the kompang beat action.

6.5 IMPLEMENTATION TOOLS

The Faqeh Abahata learning app testing process was done and the environment for the software and hardware were established for the implementation process. The minimum requirements for the software and hardware in a mobile environment to run and operate the Faqeh Abahata software were determined.

6.5.1 Software Requirements

The following are the software requirements to use the prototype (see Table 6.2):

Table 6.2: Software Requirements

Description	**Requirement**
OS (Android)	To provide .XML file runtime
Other requirements	Mobile devices with Android OS

6.5.2 Hardware Requirements

The following are the hardware requirements to use the prototype (see Table 6.3):

Table 6.3: Hardware Requirements

Description	**Requirement**
Operating System	The Android runtime layer: DVM and the core libraries (such as Java or IO)
Random Access Memory	512MB (1GB recommended) or above
Monitor	Flexible to any size of mobile screen
Others	Touch screen or touch pen for mobile environments

6.6 THE EXECUTION OF FAQEH ABAHATA LEARNING APP

This section gives a clear view on the Faqeh Abahata learning app prototype by presenting several APIs of the real menu followed by an explanation of each of them. This section consists of the sequence of the module from the beginning of the menu until the end of the app.

6.6.1 Main Icon

The main icon in a mobile environment shows the intro icon of the Faqeh Abahata learning app, as shown in Figure 6.6 below. It contains greetings to the user at the beginning of the screen show.

Figure 6.6: Main Icon screen menu

6.6.2 Main page menu

The main page interface shows a button of the main menu which has six buttons, as shown in Figure 6.7. It contains the greetings (voice of a child) to the user at the beginning of the screen show. The 'Bridge of Memory Song' button is used to load the submenu where the user can listen to the song provided. Meanwhile, the 'Listening' button is used to load the listening menu where the user can click/touch the '*Jawi'* alphabets to listen to the pronunciation of the ***hijaiyah*** letters. The 'Recognizing' button refers to the part where students can play while learning. Next, the 'Mentioning' button refers to a video recording that allows the student to pronounce the letters well. The 'Writing' button refers to the part of '*Jawi'* learning by writing method. Meanwhile, the

‘Kompang’ button refers to the animation of the *Kompang* instrument to help students use the method of beating on the drums.

Figure 6.7: Main Page Screen Interface.

6.6.3 Second Menu: Bridge of Memory Song

The user will see the menu options to play the song, as shown in Figure 6.8. There are three option buttons to play the song appropriately. The user can choose to listen to the *Selawat badar* song by pressing the ‘Selawat Badar’ button and the user interface will appear as shown in Figure 6.9 below, after which the user can then click the ‘Play’ button to start listening. To listen to the *Solmisasi* song, the ‘Solmisasi’ button is clicked and the user interface will appear, as shown in Figure 6.10 below, after which the user can then click the ‘Play’ button to start listening. Then to listen to the *Kitab* Quran song, this is done by clicking the ‘Kitab Quran’ button and the user interface will appear, as shown in Figure 6.11, after which the user can then click the ‘Play’ button to start listening.

Figure 6.8: Second menu of Bridge of Memory Song button.

Figure 6.9: Selawat Badar user interface

Figure 6.10: Solmisasi user interface

Figure 6.11: Kitab Quran user interface

6.6.4 Second menu: Listening

This menu screen includes two buttons that are the ‘Memory Bridge’ and ‘Abahata’ buttons, as shown in 6.12. The ‘Memory Bridge’ button displays a user interface as shown in Figure 6.13 below. Users can click on the squares in the interface to listen to the ‘*Jawi’* readings of four alphabets with their rhythm at once. Meanwhile, the ‘Abahata’ button displays a user interface as shown in Figure 6.14 below, where it allows the user to listen to the pronunciation for the ‘*Jawi’* alphabets by clicking on the boxes provided in the display. The circle button containing the numbers 1 to 7 is to allow the user to go to the other letters.

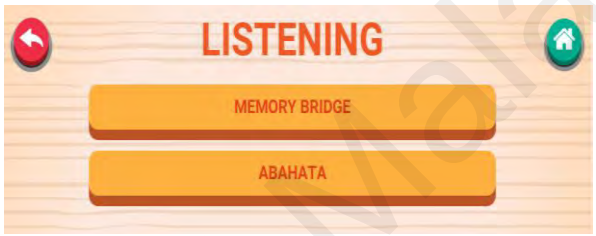


Figure 6.12: Second menu of Listening button

Figure 6.13: Memory Bridge user interface

Figure 6.14: Abahata user interface

6.6.5 Second menu: Recognizing

This menu screen includes two buttons that are the ‘Arranging’ and ‘Constructive’ buttons, as shown in Figure 6.15. The ‘Arranging’ button displays a user interface as shown in Figure 6.16(a) below. Users can drag and drop the ‘*Jawi’* alphabets to start the learning through playing the arranging game. The pop-up text and a child’s voice recording of “Good Job” appear as shown in Figure 6.16(b). Meanwhile, the circle button containing the numbers 1 to 4 is to allow the user to proceed to the other letters. The ‘Constructive’ button displays a user interface as shown in Figure 6.17(a) below, where it allows the user to construct the ‘*Jawi’* alphabets in the right places by means of click, drag and drop the letter boxes provided on the display. Similar with the Arranging activity, the pop-up text and a child’s voice recording of “Good Job” appear as shown in Figure 6.17(b). The circle button containing the numbers 1 to 7 is to allow the user to proceed to the other letters.

Figure 6.15: Second menu of Recognizing

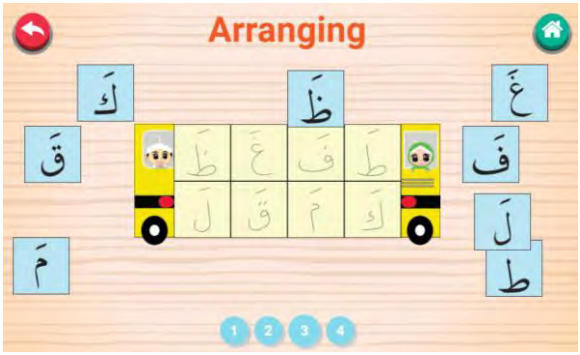


Figure 6.16 (a): Arranging user interface

Figure 6.16 (b): "Good Job" pops up action screen

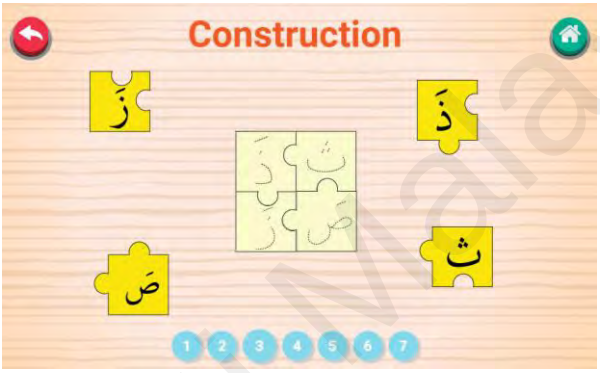


Figure 6.17(a): Construction user interface

Figure 6.17 (b): "Good Job" pops up action screen

6.6.6 Second menu: Mentioning

This menu screen shows the imitate video for the pronunciation of '*Jawi'* alphabets, as shown in Figure 6.18 below. Users can click on the square flat button provided to see

and listen to the pronunciation. The circle flat button containing the numbers 1 to 7 is to allow the user to proceed to the other letters.

Figure 6.18: Mentioning user interface

6.6.7 Second menu: Writing

This menu screen shows the user interface for writing the '*Jawi'* alphabets, as shown in Figure 6.19 below. Users can start learning to write the alphabets by trying to join the dots provided as shown in 6.20(a); the after action of joining the dots is as shown in 6.20(b).

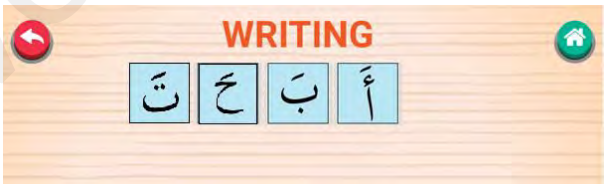


Figure 6.19: Second menu of Writing

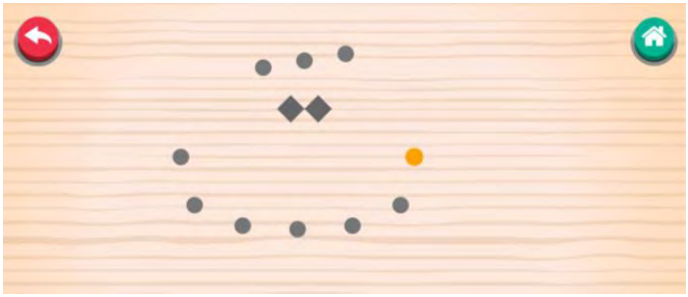


Figure 6.20(a): Writing user interface

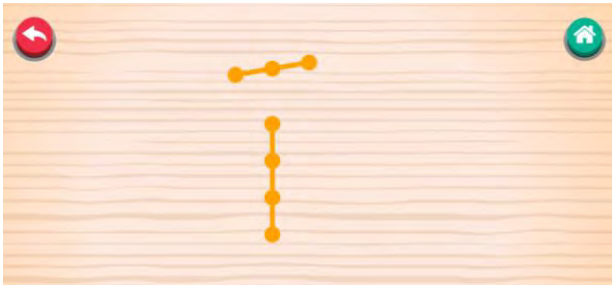


Figure 6.20(b): Writing user interface (after action)

6.6.8 Second menu: Kompang

This menu screen includes four buttons that are ‘One Letter’, ‘Two Letter’, ‘Four Letter’ and ‘Kompang Sound’ buttons, as shown in 6.21. The ‘One Letter’ button displays a user interface as shown in Figure 6.22(a) below. In this interface, the user can use a *kompang* simulation with a clickable part to listen to the pronunciation of *'Jawi'* alphabets. Users can click on that part of the *kompang* image to listen to the ‘*Jawi’* readings of one alphabet. In this part, there are two different voices to pronounce the letters, which are the voice of an ‘*ustaz’* (image of ‘*ustaz’*) as shown in Figure 6.22(a), and the voice of a child (image of ‘Female child’) as shown in Figure 6.22(b). Meanwhile, the square flat button containing the ‘*Jawi’* alphabets is to allow the user to proceed to the other letters. The ‘Two Letter’ button user interface as shown in Figure 6.23 has similar functions with the One Letter interface, which in this interface the user listens to two ‘*Jawi’* alphabets with their rhythm at once. Meanwhile, the ‘Four Letter’ button user interface as shown in Figure 6.24(a) and Figure 6.24(b) below allows the user to click or tap on the clear image (white part) of the *kompang* provided on the screen to listen to the ‘Jawi’ readings. The circle flat button containing the ‘Jawi’ alphabets is to allow the user to proceed to the other letters. Furthermore, for the ‘Kompang’ button, it displays a user interface as shown in Figure 6.25 below, where it is a simulation of the *kompang*. It allows the user to click or tap on the image of the *kompang* provided on the screen to play the *kompang* instrument.

Figure 6.21: Second menu of Kompang button

Figure 6.22(a): One Letter user interface (*uztaz*)

Figure 6.22(b): One Letter user interface (child)

Figure 6.23: Two Letter user interface

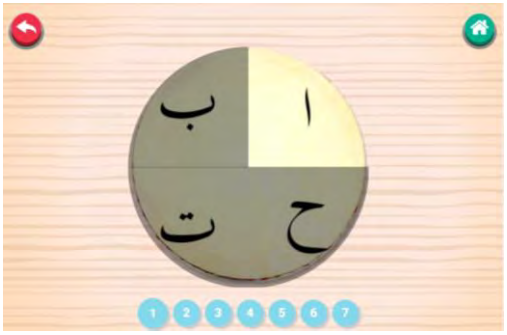


Figure 6.24(a): Four Letter user interface

Figure 6.24(b): Four Letter user interface (continued)

Figure 6.25: Kompang Rhythm user interface

6.7 FAQEH ABAHATA LEARNING APPS TESTING AND EVALUATION

Testing is the process of evaluating the Faqeh Abahata learning app prototype to verify that it has satisfied the requirements and to determine if there are differences between the expected and actual results. The testing process of the Faqeh Abahata learning app included two testing levels, which are prototype testing and user acceptance test.

6.7.1 Prototype Testing

Prototype testing was performed to examine several functionalities and services of the Faqeh Abahata learning app by running in the .XML format. By debugging and compiling all the source codes, all types of errors were recognised and eliminated. This testing was conducted with two programmers in which they tested the app to check the functionalities. Tables 6.4 to 6.8 show the sample test case for each implementation in the Faqeh Abahata learning app. See APPENDIX F for the full testing unit for this prototype.

Table 6.4: Test case for the main buttons in the main menu

Sub Test Case ID	Test Items (Features to be Tested)	Input Specification	Expected Outcome	Result
'Bridge of Memory Song' button	To verify that when a user clicks on the 'Bridge of Memory Song' button, the user can proceed to the second menu	User clicks on the 'Bridge of Memory Song' button	The screen successfully opens and user can click to proceed to the next menu	Pass
'Listening' button	To verify that when a user clicks on the 'Listening' button, the user can proceed to the second menu	User clicks on the 'Listening' button	The screen successfully opens and user can click to proceed to the next menu	Pass
'Recognizing' button	To verify that when user clicks on the 'Recognizing' button, the user can proceed to the second menu	User clicks on the 'Recognizing' button	The screen successfully opens and user can click to proceed to the second menu	Pass
'Mentioning' button	To verify that when user clicks on the 'Mentioning' button, the user can proceed to the second menu	User clicks on the 'Mentioning' button	The screen successfully opens and user can click to proceed to the second menu	Pass
'Writing' button	To verify that when user clicks on the 'Writing' button, the user can proceed to the second menu	User clicks on the 'Writing' button	The screen successfully opens and user can click to proceed to the second menu	Pass
'Kompang' button	To verify that when user clicks on the 'Kompang' button, the user can proceed to the second menu	User clicks on the 'Kompang' button	The screen successfully opens and user can click to proceed to the second menu	Pass

Table 6.5: Test case for the buttons in the second menu

Sub Test Case ID	Test Items (Features to be Tested)	Input Specification	Expected Outcome	Result
Bridge of Memory Song – 'Selawat Badar' button	To verify that when user clicks on the 'Selawat Badar' button, the user can proceed to the screen provided	User clicks on the 'Selawat Badar' button	The screen successfully opens	Pass
Bridge of Memory Song – 'Solmisasi' button	To verify that when user clicks on the 'Solmisasi' button, the user can proceed to the screen provided	User clicks on the 'Solmisasi' button	The screen successfully opens	Pass
Bridge of Memory Song – 'Kitab Quran' button	To verify that when user clicks on the 'Kitab Quran' button, the user can proceed to the screen provided	User clicks on the 'Kitab Quran' button	The screen successfully opens	Pass
Listening – 'Memory Bridge' button	To verify that when user clicks on the 'Memory Bridge' button, the user can proceed to the screen provided	User clicks on the 'Memory Bridge' button	The screen successfully opens	Pass
Listening – 'Abahata' button	To verify that when user clicks on the 'Abahata' button, the user can proceed to the screen provided	User clicks on the 'Abahata' button	The screen successfully opens	Pass
Recognizing - 'Arranging' button	To verify that when user clicks on the 'Arranging' button, the user can proceed to the screen provided	User clicks on the 'Arranging' button	The screen successfully opens	Pass
Recognizing – 'Constructive' button	To verify that when user clicks on the 'Constructive' button, the user can proceed to the screen provided	User clicks on the 'Constructive' button	The screen successfully opens	Pass
Kompang – 'One Letter' button	To verify that when user clicks on the 'One Letter' button, the user can proceed to the screen provided	User clicks on the 'One Letter' button	The screen successfully opens	Pass
Kompang – 'Two Letter' button	To verify that when user clicks on the 'Two Letter' button, the user can proceed to the screen provided	User clicks on the 'Two Letter' button	The screen successfully opens	Pass
Kompang – 'Four Letter' button	To verify that when user clicks on the 'Four Letter' button, the user can proceed to the screen provided	User clicks on the 'Four Letter' button	The screen successfully opens	Pass
Kompang – 'Kompang' Sound button	To verify that when user clicks on the 'Kompang Sound' button, the user can proceed to the screen provided	User clicks on the 'Kompang' button	The screen successfully opens	Pass

Table 6.6: Test case for the square and circle flat buttons in the user interfaces provided.

Sub Test Case ID	Test Items (Features to be Tested)	Input Specification for the Test Case	Expected Outcome	Result
Selawat Badar – 'Play' button	To verify that when user clicks on the 'Play' button, the user can listen to the song	User clicks on the 'Play' button	The song file is successfully uploaded	Pass
Solmisasi – 'Play' button	To verify that when user clicks on the 'Play' button, the user can listen to the song	User clicks on the 'Play'button	The song file is successfully uploaded	Pass
Kitab Quran – 'Play' button	To verify that when user clicks on the 'Play' button, the user can listen to the song	User clicks on the 'Play'button	The song file is successfully uploaded	Pass
'Memory Bridge' square button	To verify that when user clicks on the square button, the user can listen to the '*Jawi'* alphabets pronunciation of four letters at once	User clicks on the square button	The voice file is successfully uploaded	Pass
'Abahata' square button	To verify that when user clicks on the square button, the user can listen to the 'Jawi' alphabets pronunciation in one letter at once	User clicks on the square button	The voice file is successfully uploaded	Pass
'Abahata' circle button	To verify that when user clicks on the circle button, he can change the screen (another screen)	User clicks on the circle button	The screen successfully changes	Pass
'Mentioning' square button	To verify that when user clicks on the square buttons, the user can see and listen to the 'Jawi' alphabets pronunciation of one letter	User clicks on the square button	The video file is successfully uploaded	Pass
'Mentioning' circle button	To verify that when user clicks on the circle button, the user can change the screen (another screen)	User clicks on the circle button	The screen successfully changes	Pass
'Writing' square button	To verify that when user clicks on the square buttons, the user can drag and write the 'Jawi' alphabets	User clicks on the square buttons	The writing screen is successfully uploaded	Pass
'Writing' circle button	To verify that when user clicks on the circle button, the user can change the screen (another screen)	User clicks on the circle button	The screen successfully changes	Pass
'Arranging' circle button	To verify that when user clicks on the circle button, the user can change the screen (another screen)	User clicks on the circle button	The screen successfully changes	Pass
'Constructive' circle button	To verify that when user clicks on the circle button, the user can change the screen (another screen)	User clicks on the circle button	The screen successfully changes	Pass

Table 6.7: Test case for the touch screen on the Writing and Kompang menu screen

Sub Test Case ID	Test Items (Features to be Tested)	Input Specification for the Test Case	Expected Outcome	Result
Touch screen on Writing menu screen	To verify that user can drag to write the "Jawi" alphabet	User dragging the dots	The screen successfully writes the alphabet	Pass
Touch screen on Kompang menu screen	To verify that user can tap on the kompang to listen to the "Jawi" alphabet	User taps on the clickable part	The voice file is successfully uploaded	Pass

Table 6.8: Test case for the touch screen on the illumination of Kompang Rhythm menu screen

Sub Test Case ID	Test Items (Features to be Tested)	Input Specification for the Test Case	Expected Outcome	Result
Kompang Rhythm Touch Screen	To verify that when user clicks on the clickable screen, he can listen to the sound of kompang	User taps on the clickable screen	The sound file is successfully uploaded	Pass

6.7.2 User Acceptance Test

The user acceptance test was conducted to verify that the prototype functioned properly and this test involved the end users. 21 DS students and 14 teachers were involved as the users. This was to make sure that the objectives and the requirements of the learning apps were fulfilled. Each of the students and teachers used the learning app individually. The evaluation form was filled during this test and DS students' involvement and achievements were collected using the evaluation form (see APPENDIX G). Fourteen teachers were selected for this user acceptance test because we wanted to know their opinions on the Faqeh Abahata learning app especially on the appropriateness with the DS user.

6.7.2.1 Evaluation Design and Method

It is difficult to determine the level of real engagement of the DS students if it is solely done through feedback observation and participants' responses. This is because it is very subjective so it is difficult to assess and validate. According to McWilliam and Bailey Jr (1995), engagement is defined as the amount of time children spend actively and interact well with the environment during learning sessions. Meanwhile, Goldspink, Winter and Foster (2008) have determined engagement with involvement, well-being and thinking. Feedback from participants is conducted through experimental assessments for the purpose of validating the effectiveness of the Faqeh Abahata learning app in engaging children with DS in studying the Quran. In experiments, the point matter is to measure the level of engagement of the participants while using the learning app. In order to analyse the data from the experiments, the method of quantitative and qualitative approaches was used.

To assess the participants' engagement, there is one independent variable involved in the experiment, i.e. the degree of involvement assessed based on the Leuvan Engagement Scale developed by a team at the Development Education Research Center (Leuvan University-Belgium) under the supervision of Dr. Ferre (Bertram, Pascal, & Bertram, 1997). The use of the Leuvan Engagement Scale is to assist in knowing how deeply the participants engaged in their learning app in terms of attractiveness of the app and if it was challenging for the participants to concentrate (Brodie, 2013). The Leuvan Engagement Scale consists of nine signals that have been evaluated using the five-point scale (1 = Extremely Low, 2 = Low, 3 = Moderate, 4 = High and 5 = Extremely High). Nine signals include concentration (focus), energy, complexity/creativity, facial expressions and postures (non-verbal), persistence, precision, reaction time, verbal utterance/language (oral) and satisfaction. This method is useful in helping researchers

to evaluate and avoid the element of doubt. A detailed explanation of the list of signals and description of the five-point scale is shown in Tables 6.9 and 6.10 below.

Table 6.9: Description of Involvement Signals (Bertram & Pascal, 2002)

Involvement Signal	Description
Concentration	The attention of the child is directed toward the activity. Nothing can distract the child from his/her deep concentration.
Energy	The child invests much effort in the activity and is eager and stimulated. Such energy is often expressed by loud talking, or pressing down hard on the paper. Mental energy can be deduced from facial expressions which reveal 'hard' thinking.
Complexity and Creativity	This signal is shown when a child freely mobilises his cognitive skills and other capabilities in a more routine behaviour. The child involved cannot show more competence – he/she is at his/her very 'best'. Creativity does not mean that original products have to result, but that the child exhibits an individual touch and what he/she does furthers his/her own creative development. The child is at the very edge of his/her capabilities.
Facial Expression and Posture	Nonverbal signs are extremely important in reaching a judgment about involvement. It is possible to distinguish between 'dreamy empty' eyes and 'intense' eyes. Posture can reveal high concentration or boredom. Even when children are seen only from the back, their posture can be revealing.
Persistence	Persistence is the duration of concentration in an activity. Children who are really involved do not let go of the activity easily; they would continue with the satisfaction, flavour and intensity it gives them, and are prepared to put in the effort to prolong it. They are not easily distracted by other activities. An 'involved' activity is often more prolonged but it can be dependent on the age and the development of the child.
Precision	Involved children show special care for their work and are attentive to detail. Non-involved children gloss over such details as it is not so important to them.
Reaction Time	Children who are involved are alert and react quickly to stimuli introduced during an activity, e.g. children 'fly' to a proposed activity and show prolonged motivation and keenness.
Language	Children can show that an activity is important to them by their comments e.g. they ask for the activity repeatedly and they state that they enjoyed it.
Satisfaction	The children display a feeling of satisfaction with their achievements.

Table 6.10: Description of Five Point Scale (Bertram & Pascal, 2002)

Scale	Description
1- Extremely Low	Activity is simple, repetitive and passive. The child seems absent and displays no energy. They may stare into space or look around to see what others are doing.
2- Low	Frequently interrupted activity. The child will be engaged in the activity for some of the time that they are observed, but there will be moments of non-activity when they will stare into space, or be distracted by what is going on around them.
3- Moderate	Mainly continuous activity. The child is busy with the activity but at a fairly routine level and there are a few signs of real involvement. They make some progress with what they are doing but don't show much energy and concentration, and can be easily distracted.
4- High	Continuous activity with intense moments. The child has intense moments and at all times they seem involved. They are not easily distracted.
5- Extremely High	The child shows continuous and intense activity revealing the greatest involvement. They are concentrated, creative, energetic and persistent throughout nearly all the observed periods.

There is only one dependent variable evaluated in this experiment which is the assessment of the engagement level of participants in using learning apps. The engagement level is an indicator for measuring and identifying the effectiveness of learning apps in learning the Quran for children with DS.

6.7.2.2 Experimental Tools

The tool that has been used as the medium of learning for this experiment is the Faqeh Abahata learning app itself. This learning app consists of six categories; namely listening to the Abahata rhythm, listening to the Abahata rhythm using the ***Kompang*** illustration, learning by game: arranging, learning by game: constructing, video conference: imitation and pronunciation, and writing. The participants were given a degree of freedom to learn according to their preferences and at their own pace.

6.7.2.3 Process of Conducting Experiment

A) Participants

Thirty five participants consisting of 21 DS students and 14 teachers and parents were selected to be involved in this experiment. The participants are from KIWANIS Klang centre, Vocational Schools at PSDM Kuala Lumpur, and Integration School of Learning Disabilities at Sekolah Kebangsaan Meru 2. Some of them are verbal (able to speak) while others are still non-verbal (not able to speak). Apart from that, most of them are familiar with a touch screen gadget and are able to handle them well with only a few participants that experienced difficulty in handling the gadget.

B) Experiment Setting

The experiment was conducted in a class environment where tables and chairs were provided. This environment is important in order to avoid the participants from running away while conducting the experiment. Besides that, this setting is a habitual atmosphere for students and it is also to create a peaceful environment for the participants without any distraction from others during the experiment.

C) Experimental Procedure

The observation method for the DS students has been modified to fit the students' inabilities. This procedure started with the selection of participants in line with the scope of the study to test the Faqeh Abahata learning app. For DS students who are around six to nine years old, the experiments required the help of parents or teachers as they know how to deal with children with DS and can communicate well with them. Each session for a student was twenty minutes long. The first two minutes is a demonstration to participants on how to handle the learning app. After that, participants

were given the chance to explore for themselves while parents or teachers provided assistance if necessary. Researchers started recording their time and observed the process after three minutes when the participants began browsing the screen app. The first five minutes were actually to familiarize participants with the learning app. The observation started after five minutes and lasted for ten minutes. The last five minutes were to give students freedom and researchers observed the students to see if they spent time browsing the app.

6.7.3 Result and Analysis

This section provides the results obtained from 35 selected participants. The results obtained were based on three main things: 1) Involvement scale in the fields of concentration, energy, complexity / creativity, facial expression and posture (non-verbal), persistence, precision, reaction time, verbal utterance / language and satisfaction; 2) Satisfaction of students browsing the app; and 3) Evaluation and satisfaction of parents and teacher toward the app.

6.7.3.1 Involvement Scale: Result and Analysis

The involvement scale test was conducted to verify that the prototype functioned properly and this test involved the end users. Twenty one DS students were involved as the participants. This was to make sure that the objectives and the requirements of the learning app were fulfilled. Each of the DS students tested the Faqeh Abahata learning app prototype individually and they were observed by the researcher. A questionnaire was provided during this test and the researcher gave feedback during the observation using the questionnaire form (see APPENDIX G). The questionnaire had three parts. Part one was the respondents' information, part two was the involvement scale

evaluation for DS students, and part three was the satisfaction browsing evaluation of the Faqeh Abahata learning app in general.

Part A: Respondents' Information

Part one consisted of respondents' information and the questions were about gender and age. Figure 6.26 illustrates the respondents' age in categories and Figure 6.27 illustrates the respondents' gender.

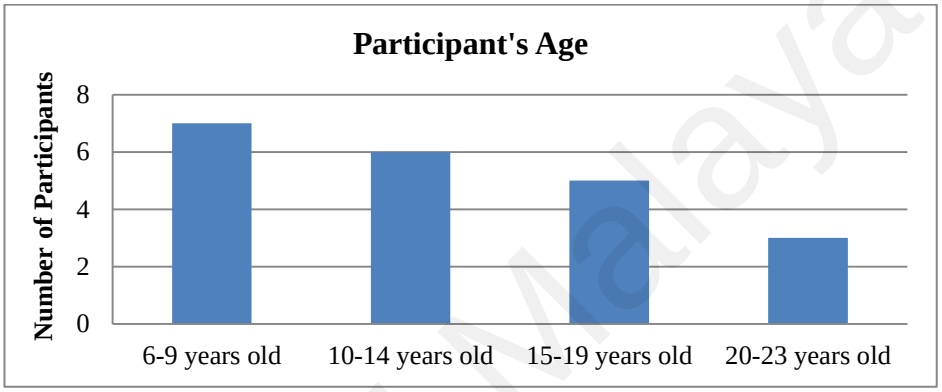


Figure 6.26: Participant's Age

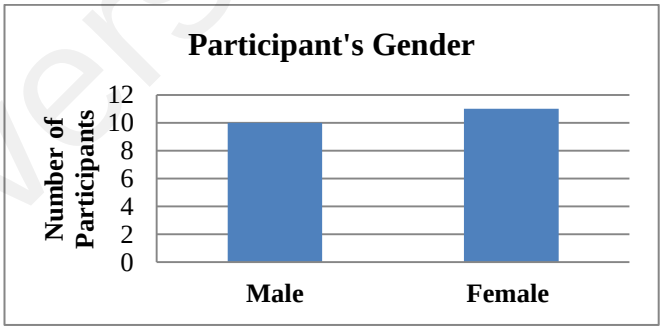


Figure 6.27: Participant's Gender

Based on the figures above, 11 female and 10 male respondents were involved in this testing observation. There were 7 participants from 6 to 9 years old and 6 participants were 10 to 14 year old students. Five of the students were in the range of 15 to 19 years old and 3 of the students were 20 to 23 years old. The reason the age of DS students as early as 6 years old was chosen is because early observations have found that they are

able to recognise the letters and can pronounce them quite well. On the other hand, the maximum age of students in the 20s is due to the fact that some of the DS students are too slow in their learning process, perhaps due to their health factor and environment.

Part B: DS Child Involvement Observation

In this part, the respondents were observed to evaluate the student's involvement towards the app by assessing through the Involvement scale in the areas of concentration, energy, complexity / creativity, facial expression and posture (non-verbal), persistence, precision, reaction time, verbal utterance / language and satisfaction. Each of the participants was observed based on the nine areas and was rated by the researcher using the five point scale as shown in Table 6.11.

Table 6.11 : The five-point scale

Scale	**5**	**4**	**3**	**2**	**1**
Meaning	Extremely High	High	Moderate	Low	Extremely Low

Table 6.12 below presents the mean and standard deviation of each of the nine areas included in the Involvement scale. Based on Table 6.12, Figure 6.28 and Figure 6.29, the results show that "Concentration" and "Facial Expression and Posture" was rated the highest while "Language" was rated the lowest compared to other signals. All the signals were rated above "moderate" except for "Language". This is mainly due to the fact that most of the participants involved are non-verbal where most of their communications were without speaking. Because of their lack in verbal skills, they were more likely to use facial expressions, posture and gestures while communicating and expressing their feelings. This is proven in Figure 6.29 where 95.2% of the participants get a "moderate (three)" and above, and if calculated from the rating "High (four)" and

above, the percentage of participants are 75.7%, while those who got a rating "Low (two)" and below is only 0.05% of the participants.

Table 6.12: Means and Standard Deviations of Nine Signals in Involvement Scale

	Mean	SD	N
Concentration	4.29	0.72	21
Energy	4.00	0.55	21
Complexity/Creativity	3.86	0.79	21
Facial Expression/Posture	4.24	0.44	21
Persistence	4.10	0.44	21
Precision	3.95	0.59	21
Reaction Time	3.57	0.60	21
Language	2.76	0.83	21
Satisfaction	4.14	0.57	21

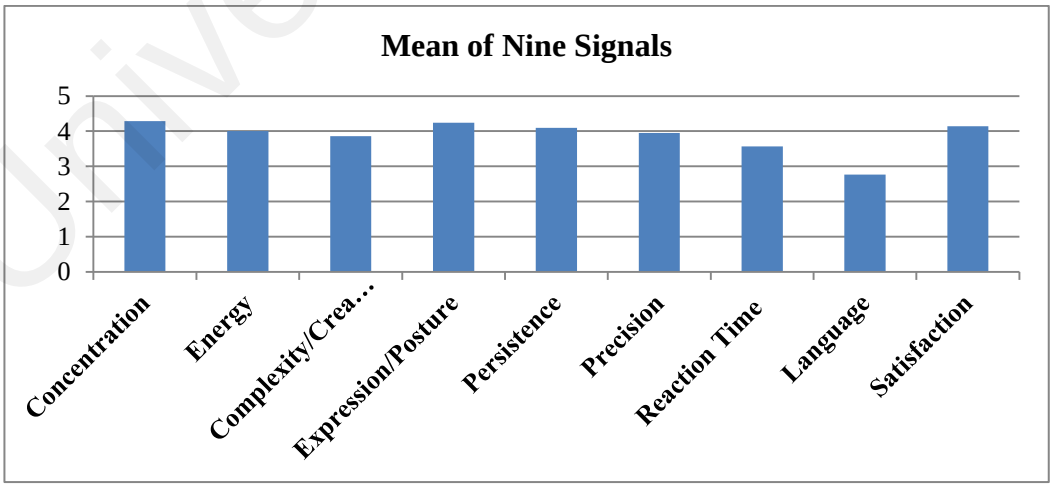
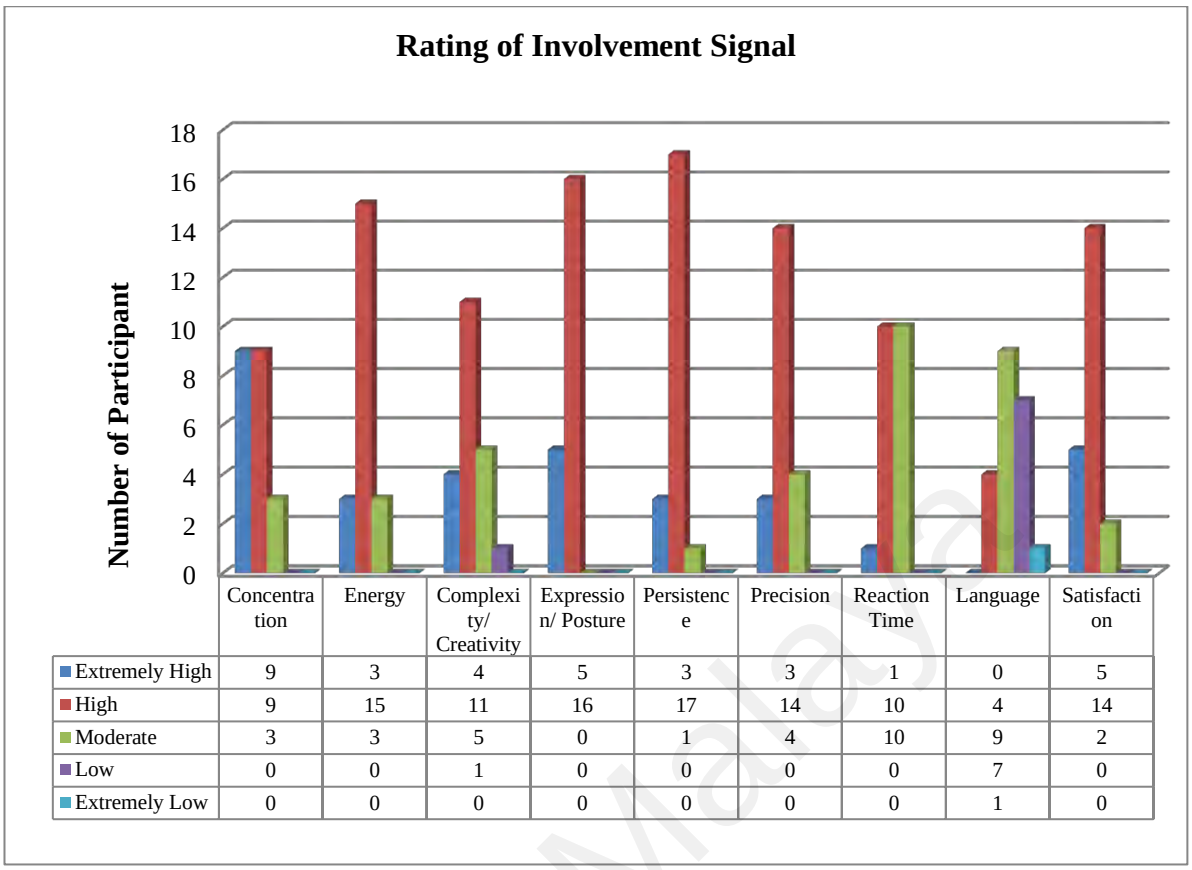


Figure 6.28: Means of Nine Signals in Involvement Scale



	Concentration	Energy	Complexity/ Creativity	Expression/ Posture	Persistence	Precision	Reaction Time	Language	Satisfaction
Extremely High	9	3	4	5	3	3	1	0	5
High	9	15	11	16	17	14	10	4	14
Moderate	3	3	5	0	1	4	10	9	2
Low	0	0	1	0	0	0	0	7	0
Extremely Low	0	0	0	0	0	0	0	1	0

Figure 6.29: Rating of Involvement Signal by Value of Scale

Table 6.13: Statistics of Regression Data

Regression Statistics	
Multiple R	0.892
R Square	0.795
Adjusted R Square	0.659
Standard Error	0.335
Observations	21

Table 6.14: Data for ANOVA

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	8	5.2271	0.6534	5.8324	0.0035
Residual	12	1.3443	0.1120		
Total	20	6.5714			

In addition, Table 6.43 and Table 6.14 show the analysis of variance (ANOVA) that was used in order to indicate the significant effect among the nine signals involved.

There is a significant positive relationship between the nine signals in the Involvement scale, which are $r(19) = 0.89$, $p<0.05$. Therefore, it is arguable that the acceptance of DS students to the Faqeh Abahata learning app can be seen when eight signals in the Involvement Scale, except "Language", have a good rating. This means that overall the Faqeh Abahata Learning app is acceptable to the DS students.

Part C: Satisfaction of Participants Browsing the Faqeh Abahata Learning app.

In this part, the respondents were observed to evaluate the student's satisfaction toward the app according to the categories identified. This was to determine that the Faqeh Abahata learning app ran in good condition and the participants were satisfied with the functionality of each item in the app. As mentioned earlier, this learning app consists of six categories; listening to the Abahata rhythm, listening to the Abahata rhythm using *Kompang* illustration, learning by game: arranging, learning by game: constructing, video conference: imitation and pronunciation, and writing. The participants were given a degree of freedom to learn according to their preferences and at their own pace. Apart from that, the frequency of participants browsing the screen according to category were identified and recorded throughout the browse session of the app.

Figure 6.30 shows the rating of student's enjoyable experience while using the Faqeh Abahata learning app. The result shows that DS students really liked to use this app whereby 90.5% of the participants had enjoyable experiences while using the app. DS in terms of learning is categorized as the weakest level of LD because of their weak memory and physical condition which sometimes does not allow them to perform physically demanding activities. Therefore, they need the best and most appropriate approach to their needs especially in learning. The Faqeh Abahata learning app has

provided the support and given the level of freedom for users to learn according to their wishes.

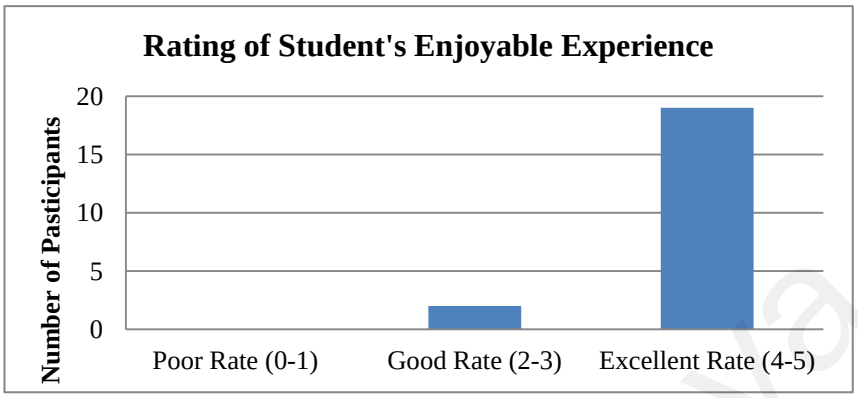


Figure 6.30: Analysis of Student's Enjoyable Experience using the app.

Figure 6.31 shows the frequency of participants browsing according to category. Based on this figure, except for the Writing category, the analysis of the other categories visited by the DS students can be said to be quite balanced. The chart indicates that 20% of them were inclined to play Learning by game: Arranging and Constructing category. Meanwhile, the remaining categories show the same percentage whereby 19% of the participants were interested to choose Video Imitation and Kompang categories. 16% of the participants chose the Listening category, while the Writing category was the last category chosen by the participants, that is 6%. Therefore, overall this means that this app is very suitable for DS students. Most of the participants who experienced difficulty with fine motor skills were not interested to choose the Writing category. This is mainly because the Writing category may not be a suitable learning activity for these students because it uses the point technique which causes confusion for the participants as it is more challenging to handle for those who have problems with their fine motor skill. As a result, it leads to a feeling of frustration and the researcher needs to get more in-depth information about activities in the training for writing for DS students.

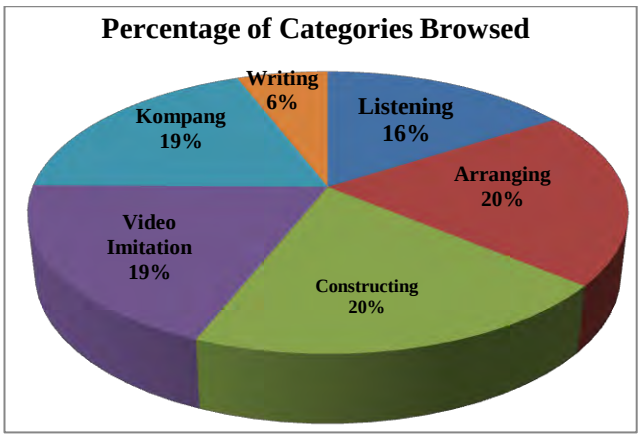


Figure 6.31: Frequency of Participants Browsing According to Category

6.7.3.2 The Evaluation of the Faqeh Abahata Learning App by Parents or Teachers

In this part, 14 participants were involved in this survey consisting of parents and teachers. The respondents were asked about the functional and non-functional requirements of the Faqeh Abahata learning app in terms of user interface, simplicity and ease of use, interactivity of the apps, and good learning skill that was applied in the app (see APPENDIX H). This part was to measure their perspectives using a five-point scale from 1 (poor) to 5 (excellent) as shown in Table 6.15. Any average score close to 5 is considered positive feedback for an acceptable and effective app. Any average score that is around 3 is considered good and satisfying. Any average score close to 1 represents that the users gave negative feedback, which means that the users were not satisfied with the Faqeh Abahata Learning app.

Table 6.15 : The five-point scale

Scale	**5**	**4**	**3**	**2**	**1**
Meaning	Excellent	Good	Satisfactory (Good)	Fairly Poor	Poor

Table 6.16 and Table 6.17 show the mean (M) and standard deviation (SD) of the evaluations given by the respondents.

Table 6.16: Evaluation from the respondents on the Faqeh Abahata Learning App

Item	Mean	SD	N
Easy to learn and understand the menu	4.29	0.73	14
Easy to use (simple)	4.21	0.70	14
Good layout design	4.14	0.66	14
Good content menu	4.21	0.58	14
Good learning app	4.36	0.63	14
Suitable for DS	4.14	0.53	14
Enjoyable app	4.50	0.52	14
Overall Satisfaction	4.29	0.61	14

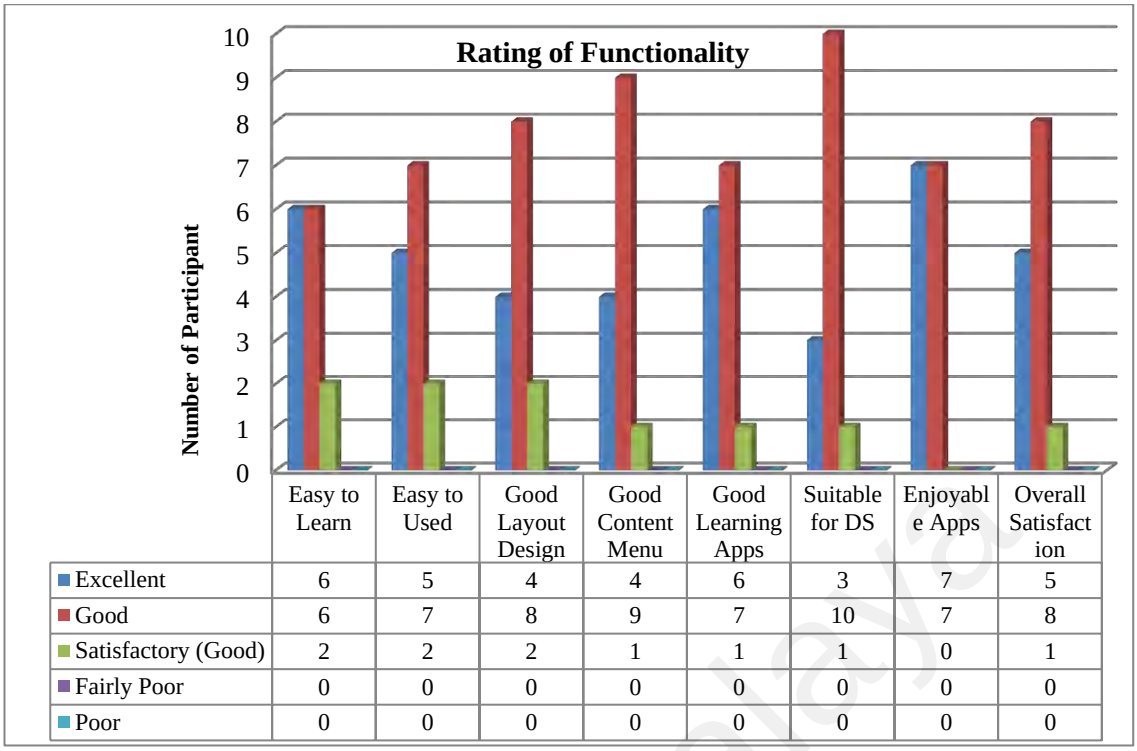
Table 6.17: Evaluation on Skill from the respondents on the Faqeh Abahata Learning App

Skill	Mean	SD	N
Listening	4.29	0.73	14
Reading	4.29	0.73	14
Writing	3.00	1.11	14
Imitation	3.93	0.86	14

From the results in Table 6.16, the ‘Enjoyable app’ item has a high mean (4.50) and it scores the lowest standard deviation (0.52). This shows that the respondents mutually agreed that the Faqeh Abahata Learning app was good and it was enjoyable to use. This is proven when the 'Good learning app' item has a second high mean score i.e. 4.36. The third high mean score that is 4.29 belongs to 'Easy to learn and understand the menu'

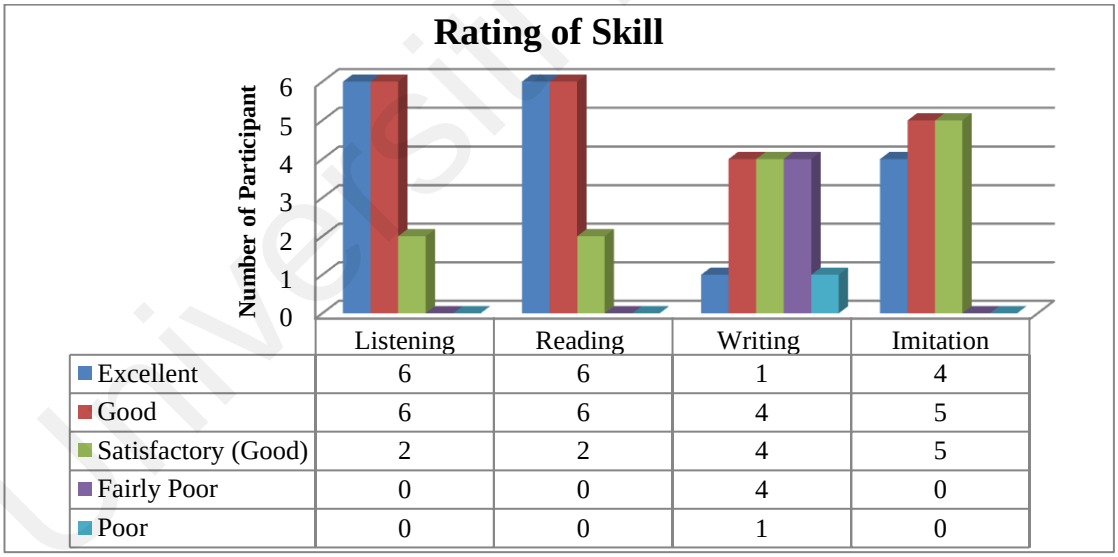
item and this shows that the Faqeh Abahata learning app is easy to understand and adopted by DS students. The 'Easy to use' and 'Good content menu' items respectively have the same mean score that is 4.21, which shows that the app is easy to use and the content is very good. Meanwhile, 'Good layout design' and 'Suitable for DS' items have the same mean score at 4.14 respectively. This shows that the Faqeh Abahata learning app has a good design and it fits well with the learning needs of students with DS. The table also shows that the overall satisfaction of the Faqeh Abahata learning app by parents and teachers is a good mean score of 4.29, which shows that most of the respondents gave positive feedback.

Furthermore, based on Table 6.17, all the four skills in the Faqeh Abahata learning app have a good mean score and above. The highest mean score is 4.29 with the lowest standard deviation score of 0.73 with each owned by the Listening and Reading skill. This shows that the Faqeh Abahata learning app has two strengths of skill, namely listening and reading. The Imitation skill gets a second high with the mean score of 3.93. With a mean score approaching four, therefore it can be said that the Faqeh Abahata learning app also has strength in terms of imitation skill and is well received by participants. Writing skills have the lowest mean score that is 3.00 with the highest standard deviation value of 1.11, and this shows that only some of the respondents gave a good rating for this skill. Statistics of all values measured in the questionnaire are combined and shown in Figure 6.32 and Figure 6.33 below for a further explanation of the evaluation by parents and teachers on the Faqeh Abahata learning app.



	Easy to Learn	Easy to Used	Good Layout Design	Good Content Menu	Good Learning Apps	Suitable for DS	Enjoyable Apps	Overall Satisfaction
Excellent	6	5	4	4	6	3	7	5
Good	6	7	8	9	7	10	7	8
Satisfactory (Good)	2	2	2	1	1	1	0	1
Fairly Poor	0	0	0	0	0	0	0	0
Poor	0	0	0	0	0	0	0	0

Figure 6.32: The number of respondents on the Functionality items of the Faqeh Abahata Learning app



	Listening	Reading	Writing	Imitation
Excellent	6	6	1	4
Good	6	6	4	5
Satisfactory (Good)	2	2	4	5
Fairly Poor	0	0	4	0
Poor	0	0	1	0

Figure 6.33: The number of respondents on the Learning Skills of the Faqeh Abahata Learning app

Based on Figure 6.32, 91.1% of the respondents gave a score of four (Good) and five (Excellent) on the functionality of the Faqeh Abahata learning app. This means that the app is also accepted and agreed to be applied to the DS students on behalf of the parents and teachers. Meanwhile, Figure 6.33 shows that all respondents agree that the Faqeh

Abahata learning app has good listening, reading and imitation learning skills. For the Writing skill evaluation, 35.7% of the respondents disagree with the writing skills found in this app because the methods provided are not suitable for DS students. According to the supervisor at KIWANIS, Klang centre, Madam Ardinsoon Yusof, the perfect technique for mastering writing skills among those with DS has several levels. In the first stage, DS students will be taught to write a point (dot) to familiarize them with the proper way of holding a pencil. This stage lasts two to four months depending on the individual with DS. After that, in the second stage, DS students will be taught to write horizontal and vertical lines. This is to familiarize the DS student in moving the wrist. In the third stage, DS students will be taught to write circles in a counter-clockwise direction. This is to familiarize students in writing letters; for example, 'a' or 'd' where the circle part is written counter-clockwise. Then, in the last stage, the DS student is introduced to writing letters. At this stage, students will be taught to write letters by teachers who will use a large line technique instead of the point technique because DS students will get confused and then quickly get bored if using the point technique in teaching them to write.

From the above explanation, for future enhancement, apps built for writing skills should use the large line technique so that DS learners can follow them well and then master the writing skills.

6.8 Summary

The aim of this phase is to evaluate the effectiveness of the Faqeh Abahata learning app in engaging children with DS in learning Al-Quran and can be adopted by DS students. This was proven by the user acceptance test involving 35 participants that included observation on 21 DS students and survey with 14 parents and teachers from KIWANIS Klang centre, Vocational School, PSDM, Kuala Lumpur, and Integration School of Learning Disabilities at Sekolah Kebangsaan Meru 2. The analysis of the result showed that DS children are able to engage and pay more attention in learning Al-Quran through the help of the Faqeh Abahata learning app. For the frequency of browsing according to category, the results showed that 90.5% of the participants found using the app enjoyable. Meanwhile, the category of Learning by game: Arranging and Construction recorded the highest percentage as compared to other categories. Apart from that, several types of participants' reactions were identified through the observation which were excited, curiosity, frustration, boredom and easily mastering the concept. In the analysis of the user acceptance test by parents and teachers, more than 97% of the respondents agreed that the Faqeh Abahata learning app has good functionality and learning skills as stated in the questionnaire. In summary, all the findings gathered from this evaluation phase are valuable information and very important for the use of future enhancement.

CHAPTER 7: DISCUSSION AND CONCLUSION

7.1 INTRODUCTION

This chapter concludes the thesis and hopefully through the process of the research, the researcher has been able to highlight the suitable requirements with regard to the learning environment for DS children. To the reader it is hoped that the questions that have lingered in their minds about how to teach in an effective way to DS children and the suitable method to recite the Quran among those with DS have been partially, if not completely, answered.

In this chapter, the four main search questions posed is explored, and the results will enable an analysis to be made that reflects the research objectives that were defined for this study. The study summarizes some factors that affect the learning environment for DS children and how these factors contributed to the researcher's design of a learning app for DS children called DSERL. In carrying out this research, the UCD method was used, which is the first phase in understanding and specifying the context of users in the early process. Secondly, the UCD method was needed to specify the user and requirement needs. The third method of UCD was to produce a design solution and finally the process was to evaluate the design. During the investigation, a number of limitations were revealed, the background and effects of which will be indicated. It is hoped that those interested in this software engineering field where consolidated together with the learning environment will add to the research done, and in this respect the researcher has attempted to list the requirements and learning needs which is not only applicable for DS children but for other LD.

7.2 AIM AND OBJECTIVE ACHIEVEMENT

The overall aim of this study was to identify the user requirement in the learning environment of DS students in Malaysia and propose one model for the requirement as a guideline for system or app learning developers to develop better technology in learning tools for children with DS. Meanwhile, the secondary aim of this study was to identify the best method in reciting the Quran among children with DS. This is to ensure that these DS children get the most appropriate way to know and learn the Quran. Thus, the researcher felt it was necessary to proactively research the end user and look at the factors contributing to the successful implementation of the learning process as the best factor of the learning requirements of DS students and to develop a model that can assist developers in their development of a suitable learning app or software for DS children.

Chapter 1 of the thesis provides a discussion on the basis of the research. This chapter reveals the lack of focus and awareness especially from the community on the needs of those with LD in the learning environment. It is a fact that the Malaysian education system is still moderate in providing conducive education to those who have learning disabilities. This may be due to a lack of facilities and specific rules that have to be adapted to the learning environment for LD individuals.

The main purpose of this research is to investigate the development of learning tools that suit LD students especially DS students, based on the UCD and HCI guideline through Mobile technology to improve the learning and teaching process. The aim of this study is to assist programmers and software developers by providing the user requirement model based on the M-Learning characteristics framework by Martin and Ertzberger (2013), and combined with the outcome of the preliminary study as a guideline to develop app learning tools for DS students. In addition, this study also

contributes to the Muslim community by providing equal opportunity for children with DS to recite the Quran just like normal children. To make it relevant with today's technology age, the aim is achieved by integrating it into an enhanced learning through Mobile learning technology that will result in the development of interactive M-learning package tools. Apart from that, this research aims to contribute to the needs of developing learning aids for learning and teaching children with DS, as the current existing teaching aids mostly lack the interactive teaching material to fulfil the requirements of learning for DS students especially in Islamic learning.

Having set the main objectives above, the researcher mapped out and executed the strategies for the research as follows:

1. A critical literature review of all relevant topics in the learning environment for DS children in order to understand the DS child, understand the environment of learning for DS children, investigate the currently available learning tools for DS in the market, the history of learning the Quran method in Malaysia, the implementation of technology enhanced learning in the environment of mobile learning, and its successful factors that influence the best implementation of learning tools was carried out.

2. Case studies of selected DS students were carried out. These case studies focused on identifying the environment of learning where it becomes the factor that influences good components to develop good learning app tools and study the method of learning the Quran that is suitable for DS children. These case studies were carried out in two sessions, that are; session one was to observe DS students in their learning process and their environment of learning to determine

their learning needs and background; and session two was to observe if the DS students were suitable with the Abahata (Al-Jabari) learning programme. This program was identified in the literature review to be suitable with DS children.

3. An interview was done in two sessions with the experts to determine the important criteria of the characteristics and learning environment of DS students and good technology learning to assist in the teaching. The second session is the facilitators' interview that was documented because they provided more detailed information about the success of the Abahata (Al-Jabari) programme for DS students.

4. A questionnaire survey was the main research tool in this study. A survey was undertaken to determine all the factors that influence the requirements of learning among DS children. The samples were taken from schools and centres in the state of Selangor and Kuala Lumpur, Malaysia. The questionnaire was divided into three sections. The first section was about the strengths of DS students in learning sessions while the second section was about the methods of learning, and the last section was about the structure of learning technology for DS students.

5. The factors and criteria to measure the good learning factor for DS children were determined. These factors and criteria indicators were applied and simulated using the questionnaire survey above.

6. Designed the user requirement model, DSERL, which is based on the best techniques that were selected, and thus will be a guideline in developing the learning software or app.

7. Developed a mobile learning app tool, the Faqeh Abahata Learning App to provide the learning of the Quran for DS children with a practical and user-friendly learning tool.

8. Verified and validated the Faqeh Abahata Learning app, as well as demonstrated its full capabilities.

Chapter 2 laid out all the considerations that were pertinent to understanding DS children in a learning environment. This is because there was a study that reported that DS children have the lowest capability in learning sessions, in terms of memory and physical movement.

This study focused on the primacy of technology that is liable to be perceived as learning apps from the perspective of education. M-learning is seen as one of the most effective methods for students, especially those with LD, to actively involve themselves in the lesson. M-learning also provides a conducive, flexible, and space-based learning environment for communicating with others, either individuals (e.g. facilitators) or components (tools – e.g. computer devices). To determine the good criteria for learning apps on DS children environment learning, a survey was carried out, and Chapter 4 described the research through the questionnaire method and tabulated the results. Overall, the analysis of the findings of the study on identifying the character of DS students, their environment of learning and requirements of learning technology aids have helped in terms of formulating the DS students' requirements in a learning environment based on the analysis of the items. Although all the items reached a high consensus, the chosen items in each section were prioritized and should be emphasized in accordance with the highest of the experts' consensus.

In addition, based on the analysis, all experts agreed that mobile technology is one of the best appropriate learning technologies for teaching and learning sessions with DS students. These are all the chosen successful factors (item) according to the ranking as shown in Table 7.1.

Table 7.1: The Chosen Successful Factors (Item)

Part		**Successful item determination**
A	Characteristics Of DS Students In Malaysia	They have the same face shape
		Some DS students may have refractive errors
		They are very friendly and cheerful
		They are very gregarious
		Their fine motor movements are very weak
B	The DS students' characters in a learning environment	They find it difficult to understand something
		They have short-term memory (forgetful)
		The content of apps should be simple and lightweight knowledge
		Teachers should always give encouragement (motivation) and praise them and be sensitive of their emotions
		Although they cannot speak well, they were able to communicate with the people around them (in their own way)
		They are easily taught through pictures or models, and sounds or songs or musical instruments
		The application of Quran learning to students with DS is seen as very nice/good for Muslim students and as a light-hearted and blessed act in life
C	The learning methods and requirements of learning technology for students with DS	They need learning by pictures or models or forms so apps must contain images, graphics and sounds, for example the use of large font
		The use of a cheerful child's voice and simple animation
		The use of learning aids that can be touched and seen
		The best practice of learning is the imitation and matching technique
		Learning style is relaxed and informal
		Always repeating the subject/learning
		Apps should motivate the DS students to continue the learning and be free of violence towards properties (aggressiveness, pugnacity) and encourage students to love learning
		Apps must help students to understand faster and not be easily confused, for example apps must show a fast response to the answer and provide greetings and tribute to the user

The data collection process that was applied in this study was based on a requirement learning need to resolve the current problems. A FDM approach was used which involved semi-structured interviews, observation (case study) on the DS students and

surveys. The interviews were conducted together with teachers, parents and other experts in DS to obtain an insight into the requirements learning needs and its learning environment including learning tools that are suitable for DS students. Meanwhile, the purpose of the observation was to directly observe the DS students to understand their learning needs and their environment of learning. In addition, this observation was also carried out to find the appropriate method for DS children to read and recognise ***hijaiyah*** letters well. Furthermore, the surveys enabled the researcher to review and analyse data about the requirements and acquire the best factor that influences the best learning tools for DS children, which could be used to support the development of a proposed user requirement model for mobile learning tools. By gathering data using this FDM method, it was possible to obtain a better appreciation of the issues than what would have been possible by using qualitative or quantitative method isolation. The data collection process is summarized in Table 7.2 below.

Table 7.2: Summary of the data collection process.

Process		Technique	Finding
1	DS Students' Observation	UCD	The learning skill in DS students that are listening, mentioning and imitating has been proven and can be enhanced in their learning environment.
2	Experts' Interview	FDM	Five themes and fifteen sub-themes has been identified to provide a Fuzzy Questionnaire (see Table 4.7 in section 4.2.2.1 Chapter 4).
3	Abahata Observation	UCD	DS students have been identified that they can receive the Abahata technique well in learning the Quran.
4	Facilitators' Interview	UCD	DS students are found to be able to accept the Abahata technique in learning the Quran well but the use of a ***'kompang'*** is seen as more suitable for DS students to replace the applause technique that was introduced in the Abahata technique.
5	Fuzzy Questionnaire	FDM	Find out the characteristics of the learning environment for DS students.

Meanwhile, Chapter 5 also reinforced the findings from Chapter 4 in the form of modelling fabrication. This chapter explained the result of this study which is a user requirement model known as DSERL that assists app developers in developing appropriate apps for DS children in the teaching and learning process. This proposed DSERL model provides the elements of individual strength of DS children in their learning environment and is to be considered as the user requirements to be used by software developers in designing and implementing learning apps for DS children.

Chapter 6 described the prototype development process for a learning app prototype based on the scratch low fidelity design that was discussed in Chapter 5. This chapter also presents the user acceptance testing which reflects the prototype implementation and testing processes. The prototype learning system that was discussed is called the Faqeh Abahata learning app for teaching the Abahata (Al-Jabari) method of reciting the Quran (the first book that introduces the pronunciation of ***hijaiyah*** letters) to children with DS. The prototype learning app development was based on the components of the model of DSERL. The prototype covers only Book 1 of the Abahata (Al-Jabari) method because the development of all the books in the Abahata (Al-Jabari) method will take a long time to finish. Therefore, as a prototype, only one of the books was developed to meet the objective and to cover the scope of this study. The testing process is often reflected as verification and validation of the app development process. This part was done to make sure that the app developer built the right product according to the specification and the quality of the implementation. Testing and debugging are important processes used in the prototype development to discover any defect or bug present in the product. A successful testing discovers any errors in the prototype and demonstrates that the functions of the prototype work according to the specification.

The user acceptance test process has been summarized in Table 7.3 below.

Table 7.3: Summary of the user acceptance test process.

User Acceptance Test		Results
1	DS child Involvement observation: technique by Involvement Test (Concentration, Energy, Complexity/Creativity, Facial Expression/Posture, Persistence, Precision, Reaction Time, Language and Satisfaction) with the Leuvan Engagement Scale.	It is arguable that the acceptance of DS students to the Faqeh Abahata learning app can be seen when eight signals involved in the Involvement Scale except "Language" have a good rating. Overall, this means that the Faqeh Abahata Learning app is acceptable to DS students. *Note*: Most DS children have a speech delay.
2	Satisfaction of browsing the Faqeh Abahata learning app	The Faqeh Abahata learning app provide support and has a level of freedom for users to learn according to their wishes. Overall, this app also is seen to be very suitable for Down syndrome students except the Writing category because it uses a point technique, which is not suitable for DS students, and is challenging to handle for those who have problems with their fine motor skill. During the test, the researcher received new information in teaching the writing technique to DS students, which in the first stage DS students will be taught to write a point (dot) at first to familiarize them in holding the pencil properly. This stage lasts two to four months depending on the individual with DS; in the second stage DS students will be taught to write horizontal and vertical lines. This is to familiarize the DS students with moving their wrist. In the third stage DS students will be taught to write circles in a counter-clockwise direction. This is to familiarize students in writing letters, for example 'a' or ‘d’ where the circle part is written counter-clockwise. Finally, in the last stage DS students are introduced to writing letters whereby teachers will use a large line technique instead of the point technique because the DS students will get confused and bored if using the point technique in teaching them to write.
3	The evaluation of the Faqeh Abahata learning app by parents/teachers	The overall satisfaction of this app received a good score which means that most of the respondents gave positive feedback on the following items: Enjoyable app, Good learning app, Easy to learn and understand the menu, Good content menu, and Easy to use (simple). The evaluation on the skills shows that this app has two strengths of skills namely listening and reading. The imitation skill gets the second highest mean score which means it also has strength in terms of imitation skill and was well received by participants.

From the discussion above, the aim and objective achievement of this study has been summarized in Table 7.4 below.

Table 7.4: Summary of the Achievement of Research Objective.

Objective (Aim)	Achievement
RO1: To identify factors associated with the learning process and the learning environment of children with DS.	Researcher achieved RO1. The researcher conducted a case study and Fuzzy questionnaire (survey) to obtain the user requirement that will cover research objective one (RO1). Details of the data collection process for observations, interviews and surveys were discussed in Chapter 4.
RO2: To obtain the appropriate method for reciting the Quran (targeted to recognise *hijaiyah* letters) for children with DS.	Researcher achieved RO2. The researcher conducted a case study that was an observation done in the Abahata (Al-Jabari) technique among DS students as participants. Details of the data collection process for observations, interviews and surveys were discussed in Chapter 4.
RO3: To propose a model to assist students with DS in the learning process which uses their learning strengths	Researcher achieved RO3. The researcher proposed the DSERL model based on the characteristics of the learning environment for DS children and M-Learning characteristic framework by Martin and Ertzberger (2013). The DSERL model is a model that emphasizes DS characteristics in the learning environment. This study used the DSERL model to develop the learning app that is appropriate with the learning strengths of children with DS. The detailed DSERL model was discussed in Chapter 5.
RO4: To evaluate the acceptance levels against the M-learning prototype app among the DS children in the process of recognising the *hijaiyah* letters.	Researcher achieved RO4. The researcher developed a prototype based on DSERL that is called the Faqeh Abahata learning app for teaching the Abahata (Al-Jabari) method of reciting the Quran (the first book that is introducing the pronunciation of ***hijaiyah*** letters) to children with DS. In the evaluation, the effectiveness was proven by the user acceptance test involving 35 participants that consisted an observation on 21 DS students and survey with 14 parents and teachers. In the analysis more than 97% of the respondents agreed that this app has good functionalities and learning skills as stated in the questionnaire. Details of the evaluation process were discussed in Chapter 6.

7.3 CONTRIBUTIONS TO KNOWLEDGE

This study has contributed in software engineering especially in software design and it concerns the development of Islamic apps for reciting the Quran. The method used in this study is the UCD process which contains four important phases that are: first phase: understanding of users, tasks and environments; second phase: incorporating user feedback to obtain the requirements; third phase: design development; and fourth phase: involvement of the users to evaluate design.

In the first and second phase, the researcher added a technique called the FDM method to get feedback from the user. The overview of the combination of these methods is illustrated in Figure 3.3 in section 3.4 in Chapter 3. This process used the FDM method because it can identify the important elements by using consensus which helps the researcher find the need for a variable level and the required sub-enablers. This ranking process will help produce data as required on the basis of experts' consensus. Then, to build the DSERL model, the researcher used the M-Learning framework characteristics by Martin and Ertzberger (2013) as a basis for the model. The researcher incorporated these framework elements with the characteristics of DS in a learning environment. The goal of the DSERL model is to improve the development of the learning app for DS students. The justification of the M-learning characteristics framework by Martin and Ertzberger (2013) in the learning environment of DS can be seen in Table 5.1 in section 5.2 in Chapter 5. Meanwhile, research on LD especially DS in Malaysia is still inadequate as compared to those carried out in developed countries. As Malaysia aims to be a developed nation by the year 2020, it must expedite the efforts in the area of expert learning which provides skilled and dedicated labour force in Malaysia.

Due to this research in Malaysia still being in its infancy, LD in Malaysia are less fortunate because of the lack of methods and procedures that should help them in meeting the demands and opportunities of getting good education like normal individuals. This study has contributed to the theoretical understanding of the special education needs for learning disabilities, especially DS, in the following ways:

1. It has identified important learning requirements in the implementation of a special education system from a Malaysian perspective. The listed user requirement learning will not be considered the most important but the ones reviewed here serve as guidelines for future developers and researchers to see and gain peer-to-peer views that will be the starting input. From this guideline, software developers and special education system makers are more able to handle what questions to do, what to avoid and what to look for in detail so that in future children with learning disabilities will have a greater opportunity to succeed in their lessons.

2. This research has also documented the characteristics of DS children in Malaysia and their learning needs in terms of learning tools and environment of learning. It is hoped that the statistics in this study will help the Ministry of Education and government agencies involved who aspire and strive to provide strategic education for those with learning needs in the education process. They can use it as an urge to make decisions and take the necessary steps to help the Malaysian government meet the vision and mission of education to become a developed nation in the near future.

3. By helping developers to develop learning apps that have good values and can provide beneficial activities in line with the Software Engineering principles. It

has provided an insight into understanding the learning skills and environment of DS students in Malaysia, and discovering the awareness concerning the requirements and needs of DS students in their learning process. Hopefully, the user requirement model that was built can assist developers in the development of learning tools for DS students so that they can enhance the learning techniques and improve the learning performance.

4. The research investigates the important needs of the user requirement process that should be considered by researchers, teachers and parents, as well as administrators in the special education unit under Kementerian Pendidikan Malaysia (KPM) in their attempts to understand the requirements needed and style of learning that are required by DS students. The data can be used by the special education unit in KPM to improve the learning among DS students so that they are able to compete in the current environment.

5. The Faqeh Abahata Learning app can be used to assist Quran learning through the Abahata (Al-Jabari) method among those with LD. This provides opportunities for Muslims with LD in Malaysia to learn and recognise the Quran just as other individuals do.

7.4 LIMITATION

A number of limitations, identified in the course of this research, should be acknowledged, which can be described as follows:

1. The interview sample size was limited to 12 respondents from different locations in Selangor and Kuala Lumpur, Malaysia. However, although this might not be considered a representative sample, the study has generated useful data and

better insight and understanding of the learning requirements of LD, especially DS. It also provided a contrasting context that could be considered in conjunction with the survey questionnaire that was carried out.

2. The questionnaire sample size was limited to 30 respondents from locations in Selangor and Kuala Lumpur (arguably in the City). Although this size is certified by the FDM method, it may not include other aspects of those who live outside the city. This aspect is also important to understand the learning environment that is better for those with LD.

3. The background of this study is focused on environment learning on DS, and does not consider any aspects of environment learning on other LD. The scope and aim of this study is just focused on teaching and learning to DS students for the sample of the current research.

4. Only mobile learning is considered in terms of developing the learning app for LD, as it is the famous learning tool for today's market. There are more types of learning tools, which include computer-based learning and online learning.

7.5 FUTURE RESEARCH

Based on some of the limitations that have been identified, there are some areas in which future research would add value to the topic discussion:

1. Extend research into urban areas because even though the situation is very much the same, there will be a variety of factors that can be used as a determining factor for user requirement learning needs for LD children.

2. Maybe with the search of the above survey data, it can make a difference and thus, provide a different approach between urban and rural areas in terms of the implementation of the process.

3. There are some researchers out there who have been searching for information related to environment learning to those with other LD; for example in Malaysia, many researchers are focusing on searching information data on those with Autism. Therefore, this information data analysis could be consolidated and combined together so that the user requirement for LD coincides with them.

4. The scope of study on technology learning tools can be expanded to include other types of technologies, for example in the DSERL model itself it can include elements of intelligence system technologies on the 'Facilitator' part as an agent system to replace the role of teachers or parents.

5. At the moment, the prototype of the Faqeh Abahata Learning app only supports Book 1 of all the books in the Abahata (Al-Jabari) training programme. This makes the Faqeh Abahata Learning app an unfinished training programme. Therefore, more effort and time are needed to finish making this training programme into a real training Abahata (Al-Jabari) programme.

7.6 CONCLUSION

As a conclusion, the prototype of the Faqeh Abahata Learning app has achieved and fulfilled the objectives and requirements of a good learning app tool as identified in the early stage of this study. Even though this app only included one book of the Abahata (Al-Jabari) training programme, it covered all the components of the DSERL model that was proposed as a guideline in the development of learning apps to DS children.

Overall, this study succeeded in producing a learning app that coincides with the learning environment for DS students. The DS students generally have a weak memory level. They have difficulty in remembering something for a long time. This is seen as a weakness in DS students in their learning. It is also difficult for them to focus or show interest in their learning. Therefore, the DSERL model tries to help DS students by helping the programmers build a learning app that coincides with DS students with regard to the strength of DS students in their learning environment.

DSERL emphasizes the characteristics of informal learning that can be made at anytime and anywhere regardless of place. The use of large and clear images is seen as appropriate with the rounded physical fingers of DS students and the usage of a child's voice are also able to attract DS students to stay interested or continue their learning sessions. In addition, the DSERL model also emphasizes the giving of greetings and tribute to DS students so they are more motivated to learn. The use of slow or non-violent animations as well as the use of lower colours will make it easier for DS students to accept the learning. Writing activities are also emphasized in the DSERL model because this activity can also be seen to help DS students in remembering the learning content well.

In this chapter, the researcher has summarized the initial objectives and the extent to which this research has met those objectives. The topic that has been addressed in this research can be considered innovative, as it sought to examine the learning environment and learning style of DS children based on the FDM analysis data and took into consideration both teachers' or parents' perspectives and students' views in the observation section.

From these surveys there are several factors in determining success in learning which is strong support in helping to understand and determine good learning needs of those with LD. It also states the documentation of important issues pertaining to the learning environment, providing insights on the process of assessment and experience of those directly involved with those with LD as well as suggestions for future research being made. It is hoped that in the future there will be more Malaysian researchers involved in the learning environment of learning with LD and ultimately will improve Malaysia's education system and the role of local communities in providing the best learning needs for those with LD in the school system.

REFERENCES

Abarbanel, J., Kol, S., & Schcolnik, M. (2006). Constructivism in theory and practice. In *English Teaching Forum* (Vol. 44, No. 4, pp. 12-19).

Adler, M., & Ziglio, E. (1996). *Gazing into the oracle: The Delphi method and its application to social policy and public health*: Jessica Kingsley Publishers.

Agheana, V., & Duţă, N. (2015). Achievements of Numeracy Abilities to Children with Down Syndrome: Psycho-Pedagogical Implications. *Procedia-Social and Behavioral Sciences, 186*, 38-45.

Ahmad, N. A., & Abu Hanifah, N. (2015). Tahap Pengetahuan Guru Pendidikan Khas Apabila Mengurus Tingkah Laku Murid Bermasalah Pembelajaran (Special Education Teacher's Level Of Knowledge In Dealing With Learning Disabilities Student). *The Asia Pacific Journal of Educators and Education (formerly known as Journal of Educators and Education), 30*(1), 1-16.

Ally, M. (2005). Using learning theories to design instruction for mobile learning devices. *Mobile learning anytime everywhere*, 5-8.

Amin Al-Muqri, M.S. 2012. "Aku dan Al-Quran." Majalah Q&A, February 10.

Andrew, C. (2004). Intelligence analysis needs to look backwards before looking forward. *History & Policy*.

Antle, A. N. (2013). Research opportunities: Embodied child–computer interaction. *International Journal of Child-Computer Interaction, 1*(1), 30-36.

Arshad, M. (2003). Penggunaan Kamera Video Bagi Meningkatkan Kemahiran Berkomunikasi Dalam Pengajaran Bahasa Melayu. *Jurnal Pendidikan, 23*, 113-122.

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual review of psychology, 52*(1), 1-26.

Beetham, H., & Sharpe, R. (2013). An introduction to rethinking pedagogy. *Rethinking pedagogy for a digital age: Designing for 21st century learning*, 41-61.

Bell, C., & Harris, D. (2013). *Evaluating and assessing for learning*: Routledge.

Bertram, C. P. T., Pascal, C., & Bertram, T. (1997). *Effective early learning: case studies in improvement*: Sage.

Bertram, T., & Pascal, C. (2002). *Early years education: An international perspective*: Qualifications and Curriculum Authority London.

Bird, G., & Buckley, S. (1999). Meeting the educational needs of pupils with Down syndrome in mainstream secondary schools. *Down Syndrome News and Update, 1*(4), 159-174.

Bland, J. M., & Altman, D. G. (1997). Statistics notes: Cronbach's alpha. *Bmj, 314*(7080), 572. BMJ 1997; 314 doi: https://doi.org/10.1136/bmj.314.7080.572 (Published 22 February 1997)

Brodie, K. (2013). *Observation, Assessment And Planning In The Early Years-Bringing It All Together: Bringing it all together*: McGraw-Hill Education (UK).

Brodie, M. L. (1992). *The promise of distributed computing and the challenges of legacy systems.* Paper presented at the British National Conference on Databases.

Bruckman, A., Bandlow, A., & Forte, A. (2002). *HCI for kids*. Retrieved from https://eva.fing.edu.uy/pluginfile.php/52761/mod_resource/content/0/biblioteca/Bruckman_Bandlow_-_HCI_for_Kids_-_IN_The_Human-Computer_Interaction_Handbook.pdf

Bruner, J. S. (2009). *The process of education*: Harvard University Press. Retrieved from http://edci770.pbworks.com/w/file/fetch/45494576/Bruner_Processes_of_Education.pdf

Buckley, S., Bird, G., Sacks, B., & Archer, T. (2006). A comparison of mainstream and special education for teenagers with Down syndrome: Implications for parents and teachers. *Down Syndrome Research and Practice, 9*(3), 54-67.

Burgoyne, K., Duff, F. J., Clarke, P. J., Buckley, S., Snowling, M. J., & Hulme, C. (2012). Efficacy of a reading and language intervention for children with Down syndrome: a randomized controlled trial. *Journal of Child Psychology and Psychiatry, 53*(10), 1044-1053.

Burgstahler, S., Corrigan, B., & McCarter, J. (2004). Making distance learning courses accessible to students and instructors with disabilities: A case study. *The Internet and higher education, 7*(3), 233-246.

Cebula, K. R., Moore, D. G., & Wishart, J. G. (2010). Social cognition in children with Down's syndrome: challenges to research and theory building. *Journal of Intellectual Disability Research, 54*(2), 113-134.

Chan, T.-W., Roschelle, J., Hsi, S., Kinshuk, Sharples, M., Brown, T., . . . Norris, C. (2006). One-to-one technology-enhanced learning: An opportunity for global research collaboration. *Research and Practice in Technology Enhanced Learning, 1*(01), 3-29.

Chang, C.-K., Chuang, T.-Y., & Kuo, W.-L. (2012). *Relationships between engagement and learning style for using VPL on game design.* Paper presented at the Digital Game and Intelligent Toy Enhanced Learning (DIGITEL), 2012 IEEE Fourth International Conference on.

Chang, I. S., Tsujimura, Y., Gen, M., & Tozawa, T. (1995). An efficient approach for large scale project planning based on fuzzy Delphi method. *Fuzzy sets and systems, 76*(3), 277-288.

Chang, P.-L., Hsu, C.-W., & Chang, P.-C. (2011). Fuzzy Delphi method for evaluating hydrogen production technologies. *International Journal of Hydrogen Energy, 36*(21), 14172-14179.

Chang, P.-T., Huang, L.-C., & Lin, H.-J. (2000). The fuzzy Delphi method via fuzzy statistics and membership function fitting and an application to the human resources. *Fuzzy sets and systems, 112*(3), 511-520.

Chantry, J., & Dunford, C. (2010). How do computer assistive technologies enhance participation in childhood occupations for children with multiple and complex disabilities? A review of the current literature. *British Journal of Occupational Therapy, 73*(8), 351-365.

Chen, C.-T. (2000). Extensions of the TOPSIS for group decision-making under fuzzy environment. *Fuzzy sets and systems, 114*(1), 1-9.

Cheng, C.-H., & Lin, Y. (2002). Evaluating the best main battle tank using fuzzy decision theory with linguistic criteria evaluation. *European journal of operational research, 142*(1), 174-186.

Chik, A. (1986). Kaedah Amali Hayati: Satu Pendekatan Mengajar Pendidikan Islam. Kuala Lumpur. *Dewan Bahasa dan Pustaka. Malaysia*.

Chin, K.-Y., & Chen, Y.-L. (2013). A mobile learning support system for ubiquitous learning environments. *Procedia-Social and Behavioral Sciences, 73*, 14-21.

Conole, G. (2013). Capturing practice and scaffolding learning design. *Distance and E-Learning in Transition*, 579-594.

Cortiella, C., & Horowitz, S. H. (2014). The state of learning disabilities: Facts, trends and emerging issues. *New York: National Center for Learning Disabilities*.

Cowan, J. E. (2008). Strategies for planning technology-enhanced learning experiences. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 82*(2), 55-59.

Cowen, M., Lemon, A., & Gill-Hesselgrave, D. (2014). User-Centered Design (UCD) Process Description (No. SPAWAR/SCP-TR-2061). *Space And Naval Warfare Systems Center Pacific San Diego Ca*.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *psychometrika, 16*(3), 297-334.

Daunhauer, L. A., Fidler, D. J., Hahn, L., Will, E., Lee, N. R., & Hepburn, S. (2014). Profiles of everyday executive functioning in young children with Down syndrome. *American journal on intellectual and developmental disabilities, 119*(4), 303-318.

de Menezes, L. D. C., Massetti, T., Oliveira, F. R., de Abreu, L. C., Malheiros, S. R. P., Trevizan, I. L., . . . de Mello Monteiro, C. B. (2015). Motor Learning and Virtual Reality in Down Syndrome; a literature review. *International Archives of Medicine, 8*.

DeWitt, D., Alias, N., Siraj, S., Yaakub, M. Y., Ayob, J., & Ishak, R. (2013). The potential of Youtube for teaching and learning in the performing arts. *Procedia-Social and Behavioral Sciences, 103*, 1118-1126.

DfES Research Digest. 2002. Retrieved from 2002https://www.education.gov.uk/publications/eOrderingDownload/RD2002.pdf.

Dodd, B., & Thompson, L. (2001). Speech disorder in children with Down's syndrome. *Journal of Intellectual Disability Research, 45*(4), 308-316.

Dowling, K. (1999). Limbless locomotion: learning to crawl. Paper presented at *the Robotics and Automation*, 1999. Proceedings. 1999 IEEE International Conference on.

Druin, A. (2002). The role of children in the design of new technology. *Behaviour and information technology, 21*(1), 1-25.

Dykens, E., Hodapp, R., & Evans, D. (2006). Profiles and development of adaptive behavior in children with Down syndrome. *Down Syndrome Research and Practice, 9*(3), 45-50.

Earthy, J., Jones, B. S., & Bevan, N. (2001). The improvement of human-centred processes—facing the challenge and reaping the benefit of ISO 13407. *International Journal of Human-Computer Studies, 55*(4), 553-585.

Ebner, M., Stickel, C., & Kolbitsch, J. (2010). *iPhone/iPad Human Interface Design.* Paper presented at the USAB.

Edimansyah, B., Rusli, B., Naing, L., & Mazalisah, M. (2006). Reliability and construct validity of the Malay version of the Job Content Questionnaire (JCQ). *Southeast Asian journal of tropical medicine and public health, 37*(2), 412.

Ertmer, P. A., & Newby, T. J. (2013). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance Improvement Quarterly, 26*(2), 43-71.

Feeley, K., & Jones, E. (2008). Strategies to address challenging behaviour in young children with Down syndrome. *Down Syndrome Research and Practice, 12*(2), 153-163.

Felder, R. M., & Silverman, L. K. (1988). Learning and teaching styles in engineering education. *Engineering education, 78*(7), 674-681.

Fidler, D., Hepburn, S., & Rogers, S. (2006). Early learning and adaptive behaviour in toddlers with Down syndrome: evidence for an emerging behavioural phenotype? *Down Syndrome Research and Practice, 9*(3), 37-44.

Fleming, N., & Baume, D. (2006). Learning Styles Again: VARKing up the right tree! *Educational developments, 7*(4), 4.

Fletcher, H., & Buckley, S. (2002). Phonological awareness in children with Down syndrome. *Down Syndrome Research and Practice, 8*(1), 11-18.

Fowler, A. E. (1999). The challenge of linguistic mastery in Down syndrome. *Down syndrome: A promising future, together*, 165-182.

Garrett, M. K., & Crump, W. D. (1980). Peer acceptance, teacher preference, and self-appraisal of social status among learning disabled students. *Learning Disability Quarterly, 3*(3), 42-48.

Garrison, D. R. (2011). *E-learning in the 21st century: A framework for research and practice*: Taylor & Francis.

Garrison, D. R., Anderson, T., & Archer, W. (2001). Critical thinking, cognitive presence, and computer conferencing in distance education. *American Journal of distance education, 15*(1), 7-23.

Godwin-Jones, R. (2010). Emerging technologies from memory palaces to spacing algorithms: approaches to secondlanguage vocabulary learning. *Language, Learning & Technology, 14*(2), 4-11.

Goldspink, C., Winter, P., & Foster, M. (2008). Student engagement and quality pedagogy. Paper presented at the *European Conference on Educational Research in Goteborg*.

Goyen, T. A., Lui, K., & Woods, R. (1998). Visual-motor, visual-perceptual, and fine motor outcomes in very-low-birthweight children at 5 years. *Developmental Medicine & Child Neurology, 40*(2), 76-81.

Grieco, J., Pulsifer, M., Seligsohn, K., Skotko, B., & Schwartz, A. (2015). Down syndrome: Cognitive and behavioral functioning across the lifespan. Paper presented at the *American Journal of Medical Genetics Part C: Seminars in Medical Genetics.*

Gulliksen, J., Göransson, B., Boivie, I., Blomkvist, S., Persson, J., & Cajander, Å. (2003). Key principles for user-centred systems design. *Behaviour and information technology, 22*(6), 397-409.

Harris, J., Mishra, P., & Koehler, M. (2009). Teachers' technological pedagogical content knowledge and learning activity types: Curriculum-based technology integration reframed. *Journal of Research on Technology in Education, 41*(4), 393-416.

Haug, E., Torsheim, T., & Samdal, O. (2008). Physical environmental characteristics and individual interests as correlates of physical activity in Norwegian secondary schools: The health behaviour in school-aged children study. *International Journal of Behavioral Nutrition and Physical Activity, 5*(1), 47.

Hein, G. (1991). Constructivist learning theory. *Institute for Inquiry. Available at:/http://www. exploratorium. edu/ifi/resources/constructivistlearning. htmlS*.

Herrington, J., Oliver, R., & Reeves, T. C. (2003). Patterns of engagement in authentic online learning environments. *Australasian Journal of Educational Technology, 19*(1).

Herrington, J., Reeves, T. C., & Oliver, R. (2014). Authentic learning environments *Handbook of research on educational communications and technology* (pp. 401-412): Springer.

Hjetland, T. (1995). Technology and the Special Education Classroom. Reproduce by *The Educational Resources Information Center* (ERIC). Retrieved from https://files.eric.ed.gov/fulltext/ED386144.pdf

Hourcade, J. P. (2015). *Child-computer interaction* [First Edition]. Retrieved from http://www.homepage.cs.uiowa.edu/~hourcade/book/child-computer-interaction-first-edition.pdf

Hsu, C.-C., & Sandford, B. A. (2007). The Delphi technique: making sense of consensus. *Practical assessment, research & evaluation, 12*(10), 1-8.

Hsu, Y.-L., Lee, C.-H., & Kreng, V. B. (2010). The application of Fuzzy Delphi Method and Fuzzy AHP in lubricant regenerative technology selection. *Expert Systems with Applications, 37*(1), 419-425.

Hussin, S. S., Alias, N., & DeWitt, D. (2013). Application of Fuzzy Delphi Method in Educational Research.

Hwang, G.-J., & Chang, H.-F. (2011). A formative assessment-based mobile learning approach to improving the learning attitudes and achievements of students. *Computers & Education, 56*(4), 1023-1031.

Hwang, G.-J., Tsai, P.-S., Tsai, C.-C., & Tseng, J. C. (2008). A novel approach for assisting teachers in analyzing student web-searching behaviors. *Computers & Education, 51*(2), 926-938.

Hwang, G.-J., & Wu, P.-H. (2014). Applications, impacts and trends of mobile technology-enhanced learning: a review of 2008–2012 publications in selected SSCI journals. *International Journal of Mobile Learning and Organisation, 8*(2), 83-95.

Hwang, G. J., & Tsai, C. C. (2011). Research trends in mobile and ubiquitous learning: A review of publications in selected journals from 2001 to 2010. *British Journal of Educational Technology, 42*(4).

Iarocci, G., Virji-Babul, N., & Reebye, P. (2006). The Learn at Play Program (LAPP): merging family, developmental research, early intervention, and policy goals for children with Down syndrome. *Journal of Policy and Practice in Intellectual Disabilities, 3*(1), 11-21.

Ikromah, L. (2015). Pengaruh perceived behavioral control, dukungan sosial, dan religiusitas terhadap penerimaan diri orang tua yang memiliki anak down syndrome. Gelar Sarjana Psikologi (S.Psi), Fakultas Psikologi, Universitas Islam Negeri Sharif Hidayatullah, Jakarta.

Inkpen, K. M. (2001). Drag-and-drop versus point-and-click mouse interaction styles for children. *ACM Transactions on Computer-Human Interaction (TOCHI), 8*(1), 1-33.

Irnawati, A., S.Sarah, I., & Zulkifli, M. Y. (2012). Kaedah Al-Jabari: Suatu Pengenalan. In International Seminar on al-Quran in Contemporary Society (SQ2012) (pp. 1–16).

Ishikawa, A., Amagasa, M., Shiga, T., Tomizawa, G., Tatsuta, R., & Mieno, H. (1993). The max-min Delphi method and fuzzy Delphi method via fuzzy integration. *Fuzzy sets and systems, 55*(3), 241-253.

Ismail, D., Khairuldin, W. M. K. F. W., & Mohammad, M. (2014). Perkembangan dan Masalah Pembelajaran al-Quran dalam Program j-QAF di Malaysia/Progress and Learning Problems of the Quran in j-QAF Program in Malaysia. *Islamiyyat, 36*(2), 57.

Janier, J. B., Shafie, A., Taha, M. F., Mohamad, N. B., Ahmad, W. F. W., & Yussof, R. L. (2015). Need Analysis for Down Syndrome Children to Develop a Learning Material on Numbers with the Aid of Multimedia Technology. *International Journal of Social Science and Humanity*, 5(1), 107.

JISC InfoNet. (2011). Rettrieved from https://www.jisc.ac.uk/reports/information-legislation-and-management-survey-2011

Jokela, T., Iivari, N., Matero, J., & Karukka, M. (2003, August). The standard of user-centered design and the standard definition of usability: analyzing ISO 13407 against ISO 9241-11. In *Proceedings of the Latin American conference on Human-computer interaction* (pp. 53-60). ACM.

Jones, H., & Twiss, B. C. (1978). *Forecasting technology for planning decisions* (No. 658.4 J6). London, UK: Macmillan Press Ltd.

Kabir, G., & Sumi, R. (2012). Integrating fuzzy Delphi method with artificial neural network for demand forecasting of power engineering company. *Management Science Letters, 2*(5), 1491-1504.

Kaptelinin, V., & Bannon, L. J. (2012). Interaction design beyond the product: Creating technology-enhanced activity spaces. *Human–Computer Interaction, 27*(3), 277-309.

Kay, A. C. (1972, August). A personal computer for children of all ages. In *Proceedings of the ACM annual conference-Volume 1* (p. 1). ACM.

Kearney, M., Schuck, S., Burden, K., & Aubusson, P. (2012). Viewing mobile learning from a pedagogical perspective. *Research in Learning Technology, 20*(1), 14406.

Kelly, B., Phipps, L., & Swift, E. (2004). Developing a holistic approach for e-learning accessibility. *Canadian Journal of Learning and Technology/La revue canadienne de l'apprentissage et de la technologie, 30*(3).

Kelly, S. R., Mazzone, E., Horton, M., & Read, J. C. (2006, October). Bluebells: a design method for child-centred product development. In *Proceedings of the 4th Nordic conference on Human-computer interaction: changing roles* (pp. 361-368). ACM.

Kennedy, G., Judd, T., Dalgarno, B., & Waycott, J. (2010). Beyond natives and immigrants: exploring types of net generation students. *Journal of computer assisted learning, 26*(5), 332-343.

Keppell, M. (2014). Personalised learning strategies for higher education. In *The future of learning and teaching in next generation learning spaces* (pp. 3-21). Emerald Group Publishing Limited.

Keppell, M., Suddaby, G., & Hard, N. (2015). Assuring best practice in technology-enhanced learning environments. *Research in Learning Technology, 23*(1), 25728.

Kim, M. C., & Hannafin, M. J. (2011). Scaffolding problem solving in technology-enhanced learning environments (TELEs): Bridging research and theory with practice. *Computers & Education, 56*(2), 403-417.

King, G., Zwaigenbaum, L., King, S., Baxter, D., Rosenbaum, P., & Bates, A. (2006). A qualitative investigation of changes in the belief systems of families of children with autism or Down syndrome. *Child: care, health and development, 32*(3), 353-369.

Koole, M. L. (2009). A model for framing mobile learning. *Mobile learning: Transforming the delivery of education and training, 1*(2), 25-47.

Korenberg, J. R., Chen, X., Schipper, R., Sun, Z., Gonsky, R., Gerwehr, S., . . . Disteche, C. (1994). Down syndrome phenotypes: the consequences of chromosomal imbalance. *Proceedings of the National Academy of Sciences, 91*(11), 4997-5001.

Kozhevnikov, M., Evans, C., & Kosslyn, S. M. (2014). Cognitive style as environmentally sensitive individual differences in cognition: A modern synthesis and applications in education, business, and management. *Psychological Science in the Public Interest, 15*(1), 3-33.

Kukulska-Hulme, A., Sharples, M., Milrad, M., Arnedillo-Sánchez, I., & Vavoula, G. (2009). Innovation in mobile learning: A European perspective. *International Journal of Mobile and Blended Learning (IJMBL), 1*(1), 13-35.

Kyriakou, T., Charitaki, G., & Kotsopoulou, A. (2015). Multi-Sensory Approach through the Use of ICT for the School Inclusion of a Child with Down syndrome. *Procedia Computer Science, 65*, 158-167.

Lan, Y.-F., & Huang, S.-M. (2012). Using mobile learning to improve the reflection: A case study of traffic violation. *Journal of Educational Technology & Society, 15*(2).

Lanfranchi, S., Aventaggiato, F., Jerman, O., & Vianello, R. (2015). Numerical skills in children with Down syndrome. Can they be improved? *Research in developmental disabilities, 45*, 129-135.

Laurillard, D. (2013). *Rethinking university teaching: A conversational framework for the effective use of learning technologies*: Routledge. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.457.2571&rep=rep1&type=pdf#page=61

Laurillard, D., & Ljubojevic, D. (2011). Evaluating learning designs through the formal representation of pedagogical patterns. In *Investigations of e-learning patterns: Context factors, problems and solutions* (pp. 86-105). IGI Global.

Laurillard, D., Oliver, M., Wasson, B., & Hoppe, U. (2009). Implementing technology-enhanced learning. *Technology-enhanced learning: Principles and products*, 289-306.

Levis, D. M., Harris, S., Whitehead, N., Moultrie, R., Duwe, K., & Rasmussen, S. A. (2012). Women's knowledge, attitudes, and beliefs about Down syndrome: a qualitative research study. *American Journal of Medical Genetics Part A, 158*(6), 1355-1362.

Lewthwaite, R., & Wulf, G. (2010). Social-comparative feedback affects motor skill learning. *The Quarterly Journal of Experimental Psychology, 63*(4), 738-749.

Litchfield, A., Dyson, L. E., Lawrence, E., & Bachfischer, A. (2007). Directions for mlearning research to enhance active learning. In *The Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education*.

Liu, W., Huang, D., & Zhang, Y. (2010). Research on fuzzy comprehensive evaluation of user experience. In *The Information Computing and Telecommunications* (YC-ICT), 2010 IEEE Youth Conference on.

Lloyd, D., & Dykes, J. (2011). Human-centered approaches in geovisualization design: Investigating multiple methods through a long-term case study. *IEEE Transactions on Visualization and Computer Graphics, 17*(12), 2498-2507.

Lott, I. T. (2012). Neurological phenotypes for Down syndrome across the life span. *Progress in brain research, 197*, 101.

Lowdermilk, T. (2013). *User-centered design: a developer's guide to building user-friendly applications* [1st ed.]. California, USA:" O'Reilly Media, Inc.".

Malaysia Education for All. (2015). Retrieved from https://www.moe.gov.my/index.php/my/dasar/malaysia-education-for-all-end-decade-review-report-2000-2015/book

Mallin, S. S. V., & de Carvalho, H. G. (2015). Assistive Technology and User-Centered Design: Emotion as Element for Innovation. *Procedia Manufacturing, 3*, 5570-5578.

Mao, R., Zielke, C. L., Zielke, H. R., & Pevsner, J. (2003). Global up-regulation of chromosome 21 gene expression in the developing Down syndrome brain. *Genomics, 81*(5), 457-467.

Marks, L. D., & Dollahite, D. C. (2001). Religion, relationships, and responsible fathering in Latter-day Saint families of children with special needs. *Journal of Social and Personal Relationships, 18*(5), 625-650.

Marshall, J., Tanner, J., Kozyr, Y., & Kirby, R. (2015). Services and supports for young children with Down syndrome: parent and provider perspectives. *Child: care, health and development, 41*(3), 365-373.

Martin, F., & Ertzberger, J. (2013). Here and now mobile learning: An experimental study on the use of mobile technology. *Computers & Education, 68*, 76-85.

Martin, S., Diaz, G., Sancristobal, E., Gil, R., Castro, M., & Peire, J. (2011). New technology trends in education: Seven years of forecasts and convergence. *Computers & Education, 57*(3), 1893-1906.

McGonigal, K. (2005). Teaching for transformation: From learning theory to teaching strategies. *Speaking of teaching, 14*(2).

McKinley, R. K., Manku-Scott, T., Hastings, A. M., French, D. P., & Baker, R. (1997). Reliability and validity of a new measure of patient satisfaction with out of hours primary medical care in the United Kingdom: development of a patient questionnaire. *Bmj, 314*(7075), 193.

McNutt, L., & Brennan, M. (2005, October). Work in Progress-Learning Styles and elearning, what is the Connection?. In *35th Annual Frontiers in Education* (p. F1H). IEEE.

McWilliam, R., & Bailey Jr, D. B. (1995). Effects of classroom social structure and disability on engagement. *Topics in Early Childhood Special Education, 15*(2), 123-147.

Melam, G., Buragadda, S., Alhusaini, A., & Dhamija, P. (2014). Reaction and Movement Time in Down syndrome Children under Different Visual Feedback Conditions. *J Nov Physiother, 4*(222), 2.

Mengoni, S. E., Nash, H. M., & Hulme, C. (2014). Learning to read new words in individuals with Down syndrome: Testing the role of phonological knowledge. *Research in developmental disabilities, 35*(5), 1098-1109.

Mergel, B. (1998). Instructional design and learning theory: Citeseer.

Miaskiewicz, T., & Kozar, K. A. (2011). Personas and user-centered design: How can personas benefit product design processes? *Design Studies, 32*(5), 417-430.

Mohamad, S. P. B., Yusoff, Z. B. M., & Adli, D. S. B. H. (2014). PENGAJARAN DAN PEMBELAJARAN AL-QURAN BAGI GOLONGAN KELAINAN UPAYA MENTAL: ANALISIS DARI SUMBER TRADISI ISLAM. *Jurnal Islam dan Masyarakat Kontemporari, 8*, 153-168.

Morrison, G. R., Ross, S. M., Kemp, J. E., & Kalman, H. (2010). *Designing effective instruction*: John Wiley & Sons.

Motschnig-Pitrik, R., & Standl, B. (2013). Person-centered technology enhanced learning: Dimensions of added value. *Computers in human behavior, 29*(2), 401-409.

Muhamad, M. H. (1992). Pembelajaran al-Quran Di Kalangan Pelajar-Pelajar Sekolah Menengah: Satu Tinjauan Di Daerah Kuala Terengganu. *Latihan Ilmiah Fakulti Usuluddin, Akademi Islam, Universiti Malaya*.

Murray, T. J., Pipino, L. L., & van Gigch, J. P. (1985). A pilot study of fuzzy set modification of Delphi. *Human Systems Management, 5*(1), 76-80.

Næss, K.-A. B., Lervåg, A., Lyster, S.-A. H., & Hulme, C. (2015). Longitudinal relationships between language and verbal short-term memory skills in children with Down syndrome. *Journal of experimental child psychology, 135*, 43-55.

Naismith, L., Sharples, M., Vavoula, G., & Lonsdale, P. (2004). Literature review in mobile technologies and learning.

Narayanasamy, A., Gates, B., & Swinton, J. (2002). Spirituality and learning disabilities: a qualitative study. *British Journal of Nursing, 11*(14), 948-957.

Noh, M. A. C., & Tarmizi, R. A. (2009). Persepsi Pelajar Terhadap Amalan Pengajaran Tilawah Al-Quran (Students' Perception Toward Teaching Tilawah Al-Quran). *dalam Jurnal Pendidikan Malaysia, 34*(1), 93-109.

Nor M. M. A. (2015). School Management Concerning Collaboration with Social Resources in the Community – Its Approaches and Problem. *Special Education Department, The Ministry of Education Report*. Retrieved from http://www.nise.go.jp/kenshuka/josa/kankobutsu/pub_d/d-266/d-266_15.pdf.

Oosterholt, R., Kusano, M., & de Vries, G. (1996). Interaction design and human factors support in the development of a personal communicator for children. Paper presented at *the Proceedings of the SIGCHI conference on Human factors in computing systems.*

Ortega-Tudela, J., & Gómez-Ariza, C. (2006). Computer-assisted teaching and mathematical learning in Down Syndrome children. *Journal of computer assisted learning, 22*(4), 298-307.

Othman, N., & Amiruddin, M. H. (2010). Different perspectives of learning styles from VARK model. *Procedia-Social and Behavioral Sciences, 7*, 652-660.

Park, A. H., Wilson, M. A., Stevens, P. T., Harward, R., & Hohler, N. (2012). Identification of hearing loss in pediatric patients with Down syndrome. *Otolaryngology--Head and Neck Surgery, 146*(1), 135-140.

Park, Y. (2011). A pedagogical framework for mobile learning: Categorizing educational applications of mobile technologies into four types. *The International Review of Research in Open and Distributed Learning, 12*(2), 78-102.

Piaw, C. Y. (2006). Kaedah dan Statistik Penyelidikan. *Malaysia: Mc. Graw Hill Sdn Bhd*.

Preece, J., & Rombach, H. D. (1994). A taxonomy for combining software engineering and human-computer interaction measurement approaches: towards a common framework. *International Journal of Human-Computer Studies, 41*(4), 553-583.

Prieto, J. C. S., Migueláñez, S. O., & García-Peñalvo, F. J. (2013). Understanding mobile learning: devices, pedagogical implications and research lines. *Education in the Knowledge Society, 15*(1), 20.

Priyanto, T. (2011). *Efektivitas penggunaan metode Qiraati terhadap Keamanan Mambaca AlQur'an yang Baik dan Benar.* Sarjana Pendidikan Islam, Jurusan Pendidikan Agama Islam, Fakultas Ilmu Tarbiyah dan Keguruan, Universitas Islam Negeri Sharif Hidayatullah, Jakarta.

Purser, H. R., & Jarrold, C. (2005). Impaired verbal short-term memory in Down syndrome reflects a capacity limitation rather than atypically rapid forgetting. *Journal of experimental child psychology, 91*(1), 1-23.

Radfar, I., Zolfani, S. H., & Nikjo, B. (2012). New Application of WeFA Framework and Fuzzy Delphi in Concert Locating. *American Journal of Scientific Research*(74), 108-112.

Ratz, C. (2013). Do students with Down syndrome have a specific learning profile for reading? *Research in developmental disabilities, 34*(12), 4504-4514.

Raus, H. M., Rasdi, M. N. A., Alias, N., Ibrahim, N., Khosim, N., Jaafar, N., . . . Zakaria, H. B. (2013). Pengajaran Al-Quran Braille: Isu Dan Cabaran Semasa. *QURANICA-International Journal of Quranic Research (4*(1).

Razak, K. A., & Ngah, Z. (2002). Isu dan cabaran pelaksanaan kurikulum pendidikan Islam (KBSM). *Dalam Prosiding Wacana Pendidikan Islam (Siri 1). Kurikulum Bersepadu Pendidikan Islam Menghadapi Cabaran Era Globalisasi (275-285). Bangi: Universiti Kebangsaan Malaysia*.

Roch, M., & Jarrold, C. (2008). A comparison between word and nonword reading in Down syndrome: The role of phonological awareness. *Journal of Communication Disorders, 41*(4), 305-318.

Roizen, N. J., & Patterson, D. (2003). Down's syndrome. *The Lancet, 361*(9365), 1281-1289.

Rosman, F., Alias, N., & Rahman, M. N. A. (2014). The Design of Video games in the Implementation of Malay Language Learning Among Foreign Students in an Institution of Higher Learning. *Malaysian Online Journal of Educational Technology*.

Sadik, A. (2008). Digital storytelling: A meaningful technology-integrated approach for engaged student learning. *Educational technology research and development, 56*(4), 487-506.

Sarrab, M., Elgamel, L., & Aldabbas, H. (2012). Mobile learning (m-learning) and educational environments. *International journal of distributed and parallel systems*, 3(4), 31.

Savery, J. R., & Duffy, T. M. (1995). Problem based learning: An instructional model and its constructivist framework. *Educational technology, 35*(5), 31-38.

Savidis, A., Grammenos, D., & Stephanidis, C. (2007). Developing inclusive e-learning and e-entertainment to effectively accommodate learning difficulties. *Universal Access in the Information Society, 5*(4), 401-419.

Schrum, L., Davis, N., Jacobsen, M., Lund, A., Ferhan Odabasi, H., Voogt, J., & Way, J. (2015). A Global Perspective: Current Trends and Issues. In *ICT for 21st Century Education.*

Scruggs, T. E., Brigham, F. J., & Mastropieri, M. A. (2013). Common core science standards: Implications for students with learning disabilities. *Learning Disabilities Research & Practice, 28*(1), 49-57.

Scruggs, T. E., & Mastropieri, M. A. (2000). The effectiveness of mnemonic instruction for students with learning and behavior problems: An update and research synthesis. *Journal of Behavioral Education, 10*(2), 163-173.

Selwyn, N. (2010). Looking beyond learning: Notes towards the critical study of educational technology. *Journal of computer assisted learning, 26*(1), 65-73.

Sharples, M., Arnedillo-Sánchez, I., Milrad, M., & Vavoula, G. (2009). Mobile learning. In *Technology-enhanced learning* (pp. 233-249). Springer, Dordrecht.

Sharples, M., Taylor, J., & Vavoula, G. (2010). A theory of learning for the mobile age. In *Medienbildung in neuen Kulturräumen* (pp. 87-99). VS Verlag für Sozialwissenschaften.

Shen, B., Chen, A., Tolley, H., & Scrabis, K. A. (2003). Gender and interest-based motivation in learning dance. *Journal of Teaching in Physical Education, 22*(4), 396-409.

Shen, C.-C., & Hsieh, K.-L. (2007). The study of fuzzy performance evaluation. Paper presented at the *Proceedings of the 11th WSEAS International Conference on Applied Mathematics.*

Shin, D. H., Shin, Y. J., Choo, H., & Beom, K. (2011). Smartphones as smart pedagogical tools: Implications for smartphones as u-learning devices. *Computers in Human Behavior*, 27(6), 2207-2214.

Shin, D. H. (2017). The role of affordance in the experience of virtual reality learning: Technological and affective affordances in virtual reality. *Telematics and Informatics*, 34(8)1826-1836. ttps://doi.org/10.1016/j.tele.2017.05.013

Siraj, S. (2008). *Kurikulum masa depan*: Penerbit Universiti Malaya.

Skulmoski, G., Hartman, F., & Krahn, J. (2007). The Delphi method for graduate research. *Journal of Information Technology Education: Research, 6*(1), 1-21.

Smith, E., & Jarrold, C. (2014). Grouping, semantic relation and imagery effects in individuals with Down syndrome. *Research in developmental disabilities, 35*(11), 3162-3174.

Sorathia, K., & Servidio, R. (2012). Learning and experience: Teaching tangible interaction & edutainment. *Procedia-Social and Behavioral Sciences, 64*, 265-274.

Steele, M. M. (2005). Teaching students with learning disabilities: Constructivism or behaviorism? *Current Issues in Education, 8*.

Surjono, H. D. (2011). The design of adaptive e-learning system based on student's learning styles. *International Journal of Computer Science and Information Technologies, 5*(2), 2350-2353

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International journal of medical education, 2*, 53.

Thistle, J. J., & McNaughton, D. (2015). Teaching active listening skills to pre-service speech-language pathologists: a first step in supporting collaboration with parents of young children who require AAC. *Language, speech, and hearing services in schools, 46*(1), 44-55.

Thomas, V., Remy, C., & Bates, O. (2017, June). The limits of HCD: Reimagining the anthropocentricity of ISO 9241-210. In *Proceedings of the 2017 Workshop on Computing Within Limits* (pp. 85-92). ACM.

Thompson-Schill, S. L., Ramscar, M., & Chrysikou, E. G. (2009). Cognition without control: When a little frontal lobe goes a long way. *Current directions in psychological science, 18*(5), 259-263.

Traxler, J. (2005). *Defining mobile learning.* Paper presented at the IADIS International Conference Mobile Learning.

Traxler, J. (2007). Defining, Discussing and Evaluating Mobile Learning: The moving finger writes and having writ. *The International Review of Research in Open and Distributed Learning, 8*(2).

United Nations Children's Fund (UNICEF) report. (2014). Retrieved from https://www.unicef.org/malaysia/

UNICEF. (2014). A school for all children. Inclusive Education Malaysia. Retrieved from https://www.unicef.org/malaysia/InclusiveEducationMalaysia_v4_27_May_2014.pdf

Vaishnav, R. S. (2013). Learning style and academic achievement of secondary school students. *Voice of Research, 1*(4), 1-4.

Vaithiyanathan, S. (2012). Achieving Inclusive Growth and Sustainable Development-Role of Innovative and Benchmarked KOSM Practices-A Case Study.

Van Bysterveldt, A., & Gillon, G. (2014). A descriptive study examining phonological awareness and literacy development in children with Down syndrome. *Folia Phoniatrica et Logopaedica, 66*(1-2), 48-57.

Verucci, L., Menghini, D., & Vicari, S. (2006). Reading skills and phonological awareness acquisition in Down syndrome. *Journal of Intellectual Disability Research, 50*(7), 477-491.

Vogel, D., Kennedy, D., & Kwok, R. C.-W. (2009). Does using mobile device applications lead to learning? *Journal of Interactive Learning Research, 20*(4), 469.

Wallach, D., & Scholz, S. C. (2012). User-centered design: why and how to put users first in software development *Software for people* (pp. 11-38): Springer.

Wang, C. L., & Chugh, H. (2014). Entrepreneurial learning: past research and future challenges. *International Journal of Management Reviews, 16*(1), 24-61.

Wang, F., & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments. *Educational technology research and development, 53*(4), 5-23.

Weisman, L. I., & Safford, P. L. (1971). Piagetian tasks as classroom evaluative tools. *The Elementary School Journal, 71*(6), 329-338.

Wilkinson, C. R., & De Angeli, A. (2014). Applying user centred and participatory design approaches to commercial product development. *Design Studies, 35*(6), 614-631.

Winzenried, A. (1997). Delphi Studies: The Value of Expert Opinion Bridging the Gap--Data to Knowledge.

Wong, L.-H., & Looi, C.-K. (2011). What seams do we remove in mobile-assisted seamless learning? A critical review of the literature. *Computers & Education, 57*(4), 2364-2381.

Wu, P.-H., Hwang, G.-J., & Tsai, W.-H. (2013). An expert system-based context-aware ubiquitous learning approach for conducting science learning activities. *Journal of Educational Technology & Society, 16*(4).

Yahaya, A., Ghaffar, M. N., Ramli, J., Boon, Y., & Hamid, W. Z. W. (2007). Hubungan di antara gaya pembelajaran dengan pencapaian akademik pelajar.

Yang, S. J., Chen, I. Y., & Chen, N. (2007). Enhancing the quality of e-learning in virtual learning communities by finding quality learning content and trustworthy collaborators. *Educational Technology & Society, 10*(2), 84-95.

Yasin, M., Hanafi, M., Toran, H., Tahar, M. M., Bari, S., Ibrahim, S. N. N., & Zaharudin, R. (2013). Bilik Darjah Pendidikan Khas Pada Masa Kini Dan Kekangannya Terhadap Proses Pengajaran (Current Special Education Classroom And Its Limitations Towards Teaching Process). *The Asia Pacific Journal of Educators and Education (formerly known as Journal of Educators and Education), 28*(1), 1-9.

Yilmaz, K. (2011). The cognitive perspective on learning: Its theoretical underpinnings and implications for classroom practices. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 84*(5), 204-212.

Yin, C., Song, Y., Tabata, Y., Ogata, H., & Hwang, G.-J. (2013). Developing and implementing a framework of participatory simulation for mobile learning using scaffolding. *Journal of Educational Technology & Society, 16*(2).

Yordanova, K. (2007). *Mobile learning and integration of advanced technologies in education.* Paper presented at the Proceedings of the 2007 international conference on Computer systems and technologies.

Zeng, J., An, M., & Smith, N. J. (2007). Application of a fuzzy based decision making methodology to construction project risk assessment. *International journal of project management, 25*(6), 589-600.

Zhang, D., Zhao, J. L., Zhou, L., & Nunamaker Jr, J. F. (2004). Can e-learning replace classroom learning? *Communications of the ACM, 47*(5), 75-79.