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Arabic Conversational Agent for Modern Islamic Education

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the requirements of the
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Abstract

This thesis presents research that combines the benefits of intelligent tutoring systems (ITS), Arabic conversational agents (CA) and learning theories by constructing a novel Arabic conversational intelligent tutoring system (CITS) called Abdullah. Abdullah CITS is a software program intended to deliver a tutorial to students aged between 10 and 12 years old, that covers the essential topics in Islam using natural language. The CITS aims to mimic a human Arabic tutor by engaging the students in dialogue using Modern standard Arabic language (MSA), whilst also allowing conversation and discussion in classical Arabic language (CAL).

Developing a CITS for the Arabic language faces many challenges due to the complexity of the morphological system, non-standardization of the written text, ambiguity, and lack of resources. However, the main challenge for the developed Arabic CITS is how the user utterances are recognized and responded to by the CA, as well as how the domain is scripted and maintained. This research presents a novel Arabic CA and accompanying a scripting language that use a form of pattern matching, to handle users' conversations when the user converse in MSA. A short text similarity measure is used within Abdullah CITS to extract the responses from CAL resources such as the Quran, Hadith, and Tafsir if there are no matching patterns with the Arabic conversation agent's scripts.

Abdullah CITS is able to capture the user's level of knowledge and adapt the tutoring session and tutoring style to suit that particular learner's level of knowledge. This is achieved through the inclusion of several learning theories and methods such as Gagne's learning theory, Piaget learning theory, and storytelling method. These learning theories and methods implemented within Abdullah's CITS architecture, are applied to personalise a tutorial to an individual learner.

This research presents the first Arabic CITS, which utilises established learning typically employed in a classroom environment. The system was evaluated through end user testing with the target age group in schools both in Jordan and in the UK. Empirical experimentation has produced some positive results, indicating that Abdullah CITS is gauging the individual learner's knowledge level and adapting the tutoring session to ensure learning gain is achieved.

Acknowledgment

All praise is due to Allah alone, the Sustainer of all the worlds,

Who started His Book the Quran by saying,

“[All] praise is [due] to Allah, Lord of the worlds - (2) The Entirely Merciful, the Especially Merciful, (3) Sovereign of the Day of Recompense. (4)
(*Al-Fatihah* 1:2-4)”

All praise is due to Allah, who began his creation with the Hamd (His praise and appreciation), by saying,

“[All] praise is [due] to Allah, who created the heavens and the earth and made the darkness and the light. Then those who disbelieve equate [others] with their Lord. (1) (*Al-An'am* 7:1-2)”

All praise is due to Allah, who ended it with the Hamd, by saying, after mentioning the destination of the people of Paradise and the people of the Fire, by saying,

“And you will see the angels surrounding the Throne, exalting [Allah] with praise of their Lord. And it will be judged between them in truth, and it will be said, “[All] praise to Allah, Lord of the worlds.” (75) (*Az-Zumar* 24:74-75)”

All thanks are due to Allah in the beginning and in the end, for what he has created and what He shall create.

I would like to express my gratefulness to my supervisors, Dr Keeley Crockett, Dr James O’Shea, Dr Tariq Jarad, and Dr Annabel Latham for their guidance, patience, continuous support and encouragement during my PhD study.

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Finally, in writing, there is always going to be something that can be improved or you will catch a mistake in the second, third, or even in the tenth run through, and as Abdul Raheem Albasanee Quote in the (12th Century):

“I have not seen in this day and age, that a man writes a book in which he sees no deficiency. He always thinks that if I added such and such or I removed such and such it will be better. This is an indication to the limitation of the human brain to be perfect in articulation the first time.”

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List of Abbreviations

AGDB	Arabic Grammar Database
AI	Artificial Intelligence
AIML	Artificial Intelligence Mark-up Language
ASTS	Arabic Short Text Similarity
ATA-CITS	Arabic Teaching Assistant Conversational Intelligent Tutoring System
ATPI	Average Time per Interaction
ATPU	Average Time per Utterance
CA	Conversational Agent
CAL	Classical Arabic language
CAS	Conversational Agent Scripts
CITS	Conversational Intelligent Tutoring System
CM	Conversation Manager
COAL	Colloquial Arabic language
ECA	Embodied Conversational agent
FAQ	Frequently Asked Questions
GQM	Goal, Question, Metric
GUI	Graphical User Interface
IDB	Islamic Database
ITS	Intelligent Tutoring Systems
LCA	linguistic Conversational agent
LSA	Latent Semantic Analysis
MCQ	Multiple Choice Question
MSA	Modern Standard Arabic
MST	Muslim Scholar Table
NLP	Natural Language Processing
NWT	Nobel Woman around the Messenger Table
PARADISE	Paradigm for Dialogue System Evaluation.
PBUH	Peace be upon Him
PC	Pattern Compactness
PM	Pattern Matching
POS	Part of Speech
PS	Pattern Strength
RAL	Rule Activation Level
STS	Short Text Similarity
STSS	Short Text Sentence Similarity
SVD	Singular Value Decomposition
TKB	Tutorial Knowledge Base
XML	Extensible Mark-up Language.

CHAPTER 1 INTRODUCTION

1.1. OVERVIEW

This thesis presents a novel Arabic Conversational Intelligent Tutoring System (CITS) called Abdullah. Abdullah CITS is a software program intended to converse with humans in ordinary natural language. The aim of this research is to design and develop an Arabic CITS to teach children aged 10 to 12 years old the three fundamental principles that every Muslim must learn as directed by the Prophet Muhammad (Peace be upon him). These principles/branches are to know your God, his messenger and the religion of Islam with the supportive evidences (Quran and Hadith “statements of Prophet Muhammad”).

Developing an architecture for a CITS for the Arabic language faces many challenges. Issues of complexity surrounding the Arabic language include the complexity of the morphological system, non-standardization of the written text, ambiguity, and lack of resources, such as an appropriate Arabic WordNet (lexical database) for classical Arabic language (Shaalán, 2010, AlSaif, 2012). However, the main challenge is how the user utterances are recognised and responded to by the Conversational agent to allow conversation in both Modern Standard Arabic (MSA) and Classical Arabic Language (CAL). Following a background review, the proposed architecture for developing Abdullah CITS was designed based on the use of a Pattern Matching (PM) engine. The design of Abdullah CITS adopted principles from three main areas of research, namely the Arabic language, conversational agents, and intelligent tutoring systems. This chapter touches on the key aspects of each of these areas, discussing the significance in terms of this project. This chapter provides the context and motivation of this research, a summary of contributions and a thesis structure.

1.2. Motivation and Research Questions

The Arabic language is one of the world’s most spoken languages, it is the fifth most spoken language in the world with approximately 300 million speakers in more than 20 countries ((IHW), 2014).

In most of these countries, Islam is the main religion; therefore, all the children learn about the religion of Islam and its principles from an early age. Islamic education is predominantly based on the Quran and Hadith, which are written and taught in CAL. However, in recent times the number of people who can speak and understand CAL in the Arab world has drastically reduced mainly due to the increase in the use of MSA in everyday communication. Therefore, Arab people in general often struggle to understand the CAL and consequently struggle to understand the concepts within Islam. Today even native Arabic speakers find the grammar of CAL difficult and complex. In an educational environment, the CAL is always taught within the context of Islam, by a qualified religious scholar/tutor. In the UK, CAL education is not very accessible, as students have to attend special classes or schools to learn.

These issues are the primary motivation behind this research; the researcher intends to create an Intelligent Tutoring System (ITS) that utilises artificial intelligence techniques to teach the principles of Islam in the form of conversational tutorials using both MSA and the CAL to young students. The system will make the teaching of Islamic knowledge easy and more accessible to a larger group as it will be a conversational ITS. Thus it will have all of the advantages that come with conversational agents such as being available 24 hours, accessible from any location (subject to internet access) and at a time that is convenient for the learner. The intention behind the CITS is to allow the tutoring to take place using MSA, which is used throughout the Arab world today, and link this through discourse to CAL. In order to provide relevant responses the system will extract advice from Islamic educational resources such as Quran and Hadith, while delivering a tutoring session towards a tutoring goal. In this thesis three research questions were identified:

1. Is it possible to link CAL to MSA through an Arabic CITS?
2. Is it possible to implement CAL in an educational software system (CITS)?
3. Is it possible to detect and adapt a tutoring session in the Arabic language based on the tutoring conversation?

Based on the research questions the goals and objectives of the research are outlined in the following section.

1.3. Research Goal and Objectives

The aim of this thesis was to design and develop an Arabic CITS and scripting language to teach children aged 10 to 12 years old the three fundamental principles of Islam. In addition, the Arabic CITS allows conversation, discussion and interpretation with verses from the Quran in the classical Arabic language by engaging in dialogue using modern standard Arabic language (MSA). The objectives of the research presented in this thesis were:

1. Conduct background research on existing conversational agents (CA) based on the Arabic language.
2. Investigate knowledge engineering techniques needed for the development of a Qur'anic knowledge base.
3. Designing and developing a scripting language to converse in both classical and modern standard Arabic language.
4. Implementation of a novel Arabic CITS by using a novel Arabic scripting language, Islamic knowledge base, and Arabic CA.
5. Perform an evaluation methodology to assess the ability of the Arabic CITS to cope with challenges of the Arabic language in the context of a learning environment.
6. Research and implement a tutorial knowledge base to manage the tutoring topics and investigate a new adaptive tutoring approach to handle users with different age groups and knowledge levels based on interviews with Islamic schoolteachers.
7. Research and investigate the pedagogical aspect and learning theories of tutoring related to the targeted age group (10-12 years old), and how these can be applied within the Arabic CITS.
8. Implement new learning theories/methods into an Arabic CITS to be adapted to different level of students' knowledge/understanding.
9. Research, develop and implement a novel short text similarity measure (STS), so that it can be utilised to search through the Islamic database (Quran, Hadith, and Tafsir) with more efficiency.

1.4. Contributions

The major contributions from this body of research are as follows:

1. A novel CITS architecture that is based on the Arabic language has been designed to process both MSA and CAL. The MSA (the type of Arabic language that is used by the user to interact with the system) and CAL (which is the language that is used to retrieve the information from the Islamic database sources like Quran and Hadith).
2. A knowledge base has been developed which is based on the main Islamic religion resources (Quran, Hadith, and Tafsir), and the Arabic language grammar. (Objectives 2 & 3).
3. Methodologies for creating a new Arabic scripting language have been reviewed and a new Arabic PM scripting language for MSA has been designed and developed. The scripting language is organized into a number of topics (contexts) where each topic is responsible for a part of conversation related to a specific tutorial topic (Objective 4).
4. Methodologies for creating a new short text similarity (STS) have been revised and a new Arabic STS for CAL has been designed and developed. The developed Arabic STS will extract the relevant responses from CAL resources such (Quran, Hadith, and Tafsir); if there are no matching with the Arabic scripting language (Objective 9).
5. A novel Arabic CITS called (Abdullah the Tutor) has been implemented, using the newly developed CITS Architecture, the Islamic knowledge base, the Arabic CA architecture, and the Arabic scripting language (Objectives 5 & 6).
6. A new evaluation methodology has been devised which can be utilised to test and evaluate CITS from both subjective and objective perspectives. The methodology is used in order to gauge the effectiveness of the tutoring ability of the CITS.
7. The Abdullah CITS implements the learning theories and methods suitable for teaching children aged 10-12 years old. The learning theories and methods are selected to deliver suitable teaching mechanisms for individual learners during the tutoring session (Objectives 7 & 8).

8. The difference in knowledge levels in Islamic related education in different locations (UK and Jordan) has been highlighted through an empirical study. The study was conducted to evaluate the CITS in the UK and Jordan for students aged 10 – 12 year olds.

1.5. Thesis Structure

This thesis is organised into nine chapters. The first chapter presents a general overview and motivation of the research. Chapter 2 presents a background to this thesis that introduces the Arabic language its origins and the influence of technology to the Islamic education. Chapter 3 describes conversational agents and different approaches to implementing text-based CAs based with a focus on the Arabic language. This is then followed by a review of existing pattern-matching text-based CAs that are based on the English language.

Chapter 4, outlines Intelligent Tutoring Systems (ITS), and the methods of representing 'intelligence' in an ITS is described. This is followed by a review of existing CITS that deliver tutoring to user's, followed by a discussion of the current research challenges in the field of ITS. Finally, a background review of existing learning theories and methods and the possibility to incorporate them into an ITS are analysed.

Chapter 5 proposes the development methodology and architecture used to develop the novel Arabic CITS, known as (Abdullah CITS). Chapter 6 presents the implementation of Abdullah CITS architecture and scripting language. Two experiments were undertaken in chapter 6 to measure the ability of Abdullah CITS leading the tutoring sessions, and to measure the effectiveness and robustness of the system.

Chapter 7 presents the second phase of Abdullah CITS, which is an Arabic Teaching Assistant Conversational Intelligent Tutoring System (ATA-CITS). The developed Abdullah ATA-CITS is implemented in the second phase of the research, by incorporating appropriate learning theories and methods for teaching children aged 10-12 years old. The new system is designed to adapt the tutoring content dynamically during the conversational tutorial to suit the level of individual student's knowledge and understanding.

Chapter 8 presents the implementation of Abdullah ATA-CITS architecture, and the learning theories and methods. Three experimental studies have been conducted in chapter 8 to measure the tutoring success, system robustness, and suitability of the tutoring session delivered by Abdullah ATA-CITS for the target aged group (10-12 years old). Finally, Chapter 9 concludes the thesis by highlighting its contributions and suggesting directions for future work.

**CHAPTER 2 THE ARABIC LANGUAGE: ITS CLASSIFICATION AND
ROLE IN MODERN ISLAMIC EDUCATION**

2.1. INTRODUCTION

The Arabic language is the tool, which has carried the Arab culture since the old period through to the approach of Islam; this is when the Arabic language became the most important language in the Islamic world. The Arabic language was adopted by many non-Arab nations as the Islamic empire started to grow, thus the Arabic language became an important language in the Arab world and wider regions. When Islam was founded in the 7th century (AD), it was concerned with the principles of belief and righteous conduct. The name for the religion in the Arabic language (Islam) is based on the Arabic language root s-l-m, which when translated means peace.

Education is one of the most important aspects in human development and perhaps the most influential social institution in any society. The Quran repeatedly urges Muslims to seek and obtain knowledge, many verses in Quran command this act, such as *“Then ‘Say [unto them, O Muhammad]: Can those who know and those who do not know be deemed equal? But only those who are endowed with insight will keep this in mind.”* (Quran Ch.: 39 V.:9). Nowadays this emphasis on education is wholly lost. The education system currently practiced in Muslim countries is considered obsolete and corrupted in relation to international education levels (LIESBET STEER, 2014, Goujon, 2014, Steer et al., 2014) . The taught curriculum in Muslim countries is not designed in a way were these countries can compete on the global level in terms of research and development (Al-Rashdan, 2007). In recent times this issue has become apparent. Therefore, Muslim countries are taking steps to improve their education system. However, it remains a fact that these countries are still lagging behind, since these countries in recent times have failed to produce the excellent scientists that these countries produced in the earlier periods of Islam such as Abu Bakr Muhammad Al-Razi known in the west as Rhazes (Pines, 1975). Rhazes is considered as one of the leading scholar of the early Islamic world, wrote numerous books on a range of medical and scientific subjects (Tibi, 2006).

2.2. Arabic Script

The Arabic script is a writing system adopted for writing by a number of languages such as Arabic, Urdu, Farsi, etc., and it is written in script from right to left. The Arabic language belongs to the family of Semitic languages, and is spoken by people throughout the Middle East and North Africa. There are generally three distinct forms of the Arabic language; these are Classical Arabic, Modern Standard Arabic, and Colloquial Arabic. The Arabic language is the official language of more than twenty countries, and a major spoken language by over 300 million people worldwide (Habash, 2012).

Modern Standard Arabic (MSA) is the official language throughout the Arab world. It is used in everyday communication, in the media, education, and literature (Ryding, 2005). MSA is mainly derived from the Classical Arabic language (CAL). CAL known as Classical Arabic or Qur'anic Arabic that is the standard form of the language used in the holy Quran, the religious text for Muslims.

MSA and CAL are the only two forms of Arabic languages taught in schools, universities, etc. However nowadays, the vast majority of the Arab population communicate using MSA mixed with a little CAL. The use of CAL as the language of communication has dwindled over the centuries. CAL is now for the most part of the world only used in Islamic resources and Islamic teaching.

Colloquial Arabic (COAL) is the dialectic version of MSA, and is being used in discussions by well-educated people, but is generally not used in writing. Different Arab countries have different Colloquial Arabic or "dialects", but most of these countries can understand each other (Al-Fityani and Padden, 2010).

2.2.1.1. Classical Arabic language (CAL)

The classical Arabic language originated during the 8th century BC in the Middle East region, while the earliest inscriptions in the alphabet date to the 10th century BC in Yemen (Macdonald, 2010).

The Quran was undoubtedly the first book to be composed in the classical Arabic language, and all Muslims consider the Quran as the words of God delivered through the prophet Muhammad.

This language of the Quran was a challenge to the Arabs of Makah, as at that time they were considered as masters of the classical Arabic language and they were well-known people, for their eloquent and elaborate poetry. The Quran which are the words of God states a challenge to the masters of CAL (the people of Makah), to bring a single verse that can rival that of any verse of the Quran.

Muslims strongly believe that the Quran is a miracle, because it was revealed to the Prophet Muhammad, who himself was an illiterate man who couldn't read or write let alone be able to construct such beautifully eloquent verses.

Non-Arab speakers have difficulties in differentiating between Arabic letters without the dot system or the diacritics, while native Arab readers could differentiate between the letters with the same writing form through the context of the script (Alotaiby et al., 2009). This led to ambiguity and incorrect pronunciation of the text. This was a severe problem, as the wrong recitation on the Qur'anic verses is very bad/unacceptable in Islam because the slightest variation in pronunciation can change the meaning of the word, which will alter the message.

Abu al-Aswad Al-Du'ali, set out to eradicate this major problem of ambiguity. He developed the "dot system", which is still used today in the holy Quran, Arabic textbooks, as well as other derivations of the Arabic language such as Urdu and Farsi (Ebadlh, 2013). The dot system was developed to clarify and establish distinctions, which were otherwise unclear (Graham, 2010).

In recent times, the original Qur'anic script utilised the diacritics as well as the dot system, the combination of which helps the reader much more than the earlier scripts. The script remains the same as the original however that addition of the diacritics and the dot system are implemented only to help reader while reading the text thus, reducing ambiguity and pronunciation errors.

An example of this type of script is the Musshaf Al Medina (Prophet Muhammad city's Quran), that is widely used throughout the world as a standard script. This script is illustrated in Figure 2.1.

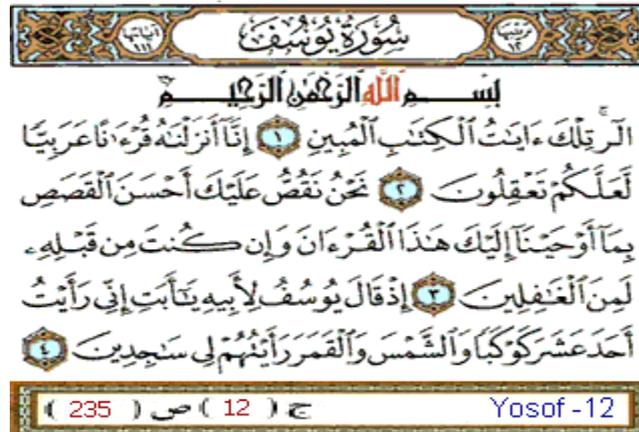


Figure 2.1 Al Medina Quran

Today Muslims only use Classical Arabic language while reciting their daily prayers, while the modern standard Arabic is used for general everyday communication such as reading the news and in teaching in the schools or universities. However, in relation to this research the development of an Arabic Conversational Intelligent Tutoring System to teach Islamic fundamentals must be able to understand and extract knowledge using CAL.

2.2.1.2. Modern Standard Arabic (MSA)

Modern Standard Arabic, is the modern descendant of Classical Arabic Language (CAL), unaffected in the essentials of its syntax but very much changed in its vocabulary and phraseology (the study of Idioms, phrasal, and verbs). The main differences between CAL and MSA are mainly in the spoken style and vocabulary, since they characterise the written traditions of very different historical and cultural eras from the early medieval period to the modern era (Amer et al., 2011).

MSA is the official written language for all countries that make up the Arab world (i.e. Iraq, Syria, Yemen, etc.), as well as the major medium of communication for public speaking and broadcasting. Ryding (2005), states, "MSA is a mark of prestige, education, and social standing". As such the focus of modern Arab people is to learn MSA before they learn the CAL. As a results of this the CAL is considered to be more complex to learn due to the rich grammar of the language.

CAL is a very deep and complex language with many different words to describe the same thing (synonyms), this makes learning the language much more difficult than MSA. The learning of MSA by children helps eliminate dialect differences and initiates Arab children into their literary heritage and historical tradition.

2.3. Islamic Education between the past and the future

Ibrahim (1968), defines Islamic Education as “the process by which the acquisition of knowledge, skill, attitudes, norms and values is facilitated in the special area of Islamic religious studies”.

In general, Islamic education consists of three levels: elementary education level (Qur’anic school, Mosque school), secondary education level (Madrassa ‘Arabic school’), and a higher education level (Islamic University).

2.3.1. A brief History of Islamic Education

Islam has continuously recognized the great value of education. The first verse from the Quran that was revealed to the Prophet Muhammad was "*Proclaim! In the name of thy Lord, who created. Created man, out of a mere clot. Proclaim! And your Lord is most bountiful; He Who taught by the Pen, taught man that which he knew not.*" (Al-Alaq 1-5) ((International), 1997).

Education has always been a main concern for Muslim people and hence education has always had a heavy prominence throughout Islamic history. Islamic education impact to art, literature, and science in the history of civilization is well known to historians. However, this could only have been possible based on a solid and effective education.

During the early eras of the Muslim empire (8th to 13th Century AD), the education system was based on the exposed and coherent sources of the Islamic knowledge i.e. Tafsir (Quran exegesis), and Hadith (Prophetic tradition) (Al-Azami, 2003).

This system led to an explosion of knowledge and impressive technological revolution throughout the Islamic Empire.

In the medieval age, the Muslim led the world in their searching of knowledge, which was discovered by a number of Muslim scientists as well as derived from other cultures such as Greek, and Chinese (Tan, 2014, Ansari, 2014).

2.3.2. Modern Islamic Education

As part of this research, educational systems in the Muslim world and the position of Islamic education within them have shown wide variations in terms of how different countries allow Islamic education to be included (Abulatifeh, 2011, Rehman, 2014).

Nowadays, teachers and lecturers from various religious schools started to include modern techniques in teaching such as demonstrations, questioning and discussion techniques (Lubis et al., 2011). These techniques are changing the traditional methods of teaching which were mainly focused on learning via textbooks or memorization.

2.3.2.1. Approaches and Techniques in Islamic Education

Islamic education is considered as an essential learning for every Muslim. Islamic education is the foundation through which the character building of a good Muslim as an individual and a member of society is developed. The methods and techniques through which Islamic knowledge has been delivered historically has however evolved in recent times.

The importance of new and emerging learning techniques such as the enhanced technological learning is becoming more apparent and their value is now more prominent (Sakat et al., 2012). Thus, nowadays teachers and lecturers play an important role in teaching Islamic education to learners by selecting and implementing new methodologies and approaches that can stimulate and better engage students (Gamal Abdul Nasir Zakaria et al., 2014). However, the main challenge in Islamic education is the lack of a complete integrated curriculum, which includes both the Islamic study along with the other fields of modern knowledge (Anas and Razali, 2013).

In modern education, many features, and approaches are implemented during the teaching learning process, such as videos, games and other educational software with the aim of delivering education to students in the most effective way to ensure the student/learner achieves the learning outcome (Hamid et al., 2009). The learning outcome is achieved through gauging a student's previous knowledge in order to adapt the tutoring to cover the learning outcomes/goals in the most efficient and meaningful method, therefore maximising the chances of the student gaining the knowledge. In order to achieve this, teachers and lectures can utilise a vast array of teaching and learning methodologies to encourage learning to occur by engaging the students to work at their own pace, to negotiate, and to practice instead of involving them with a long explanation (Scrivener, 1994).

For example, in Islamic education the story telling method has been used since the beginning of Islam. Many hadiths (the oral record of the prophet Muhammad's saying) have been delivered from one generation to another because the strong meaning and morals of the stories impacted the heart and imagination. Stories from the Quran, as well as the stories from prophet Muhammad's life and companions are considered to be the most commonly told stories between families and children (Rahiem, 2012).

As time moves on, the methods of Islamic education have evolved, while they are still based on traditional foundations. Islamic educators have started to adopt new methodologies (i.e. technology), to assist in delivering Islamic knowledge. Modern Islamic teaching has now embraced new learning methodologies and styles as well as utilising modern technologies in order to deliver Islamic education in a more up to date, dynamic and modern style.

2.3.2.2. The Importance of Technology in Islamic Education

In today's world, technology is more important than ever, students of the modern era speak the digital language of computers (Xiao, 2013). Recent studies have revealed that students learn more by utilising technology. Their writing, reading, and social networking skills are improving by using technology (Higgins et al., 2013).

In recent times, there has been increased attention in the development of software that tries to utilise computer technology to spread religious knowledge. An example of this would be the recent introduction of Quran software, which includes audio recitation of Qur'anic verses and suitable images to accompany the sound in order to teach the reading and recitation of the Quran (Ibrahim et al., 2008). Traditionally, students learning how to read and recite the Quran were limited to a teacher's knowledge and creativity (Mustaffa et al., 2013, Ariffin et al., 2013). In recent times, the technology has been implemented in a number of Islamic teaching contexts such as:

- Quran Recitation is one of the recent areas where software has been implemented in order to solve the problem of students learning correct Qur'anic recitation (Adhoni and Siddiqi, 2013). Traditionally for students to learn correct recitation they must learn with a qualified Qur'anic recitation tutor to ensure they do not make pronunciation mistakes during their recitation. The E- Hafiz system takes the place of the qualified tutor in order to teach the art of Qur'anic recitation (Muhammad et al., 2012). The E-Hafiz system has the ability to identify mistakes and enhances recitation skills of the learner, through voice recognition. With the addition of word extraction feature E-Hafiz not only tackles the whole verse but also can identify the mistakes at the word level.
- E- Halaqah is a Computerized Teaching program for the Quran; it aims to present advanced techniques and methodologies (i.e. Tajweed database) to develop an appropriate environment for self-learning of the Holy Quran and its sciences (Elhadj, 2010). The main goal of E-Halaqah is to enable users to be able to recite the holy Quran and to memorize it in a manner similar to the usual way followed in the Qur'anic schools and gatherings at mosques, known in Arabic as "Halaqah".
- Ontology Based Isnad Judgment System (Ontology-IJS), is a system that generates automatically suggested judgment of Hadith testimony (the chain of narration of hadith), and share the common understanding of the Hadith science (Dalloul, 2013). The Ontology-IJS development processes are based on structuring classical Arabic language into a set of equivalent domain of discourse, relationships, and definitions of the Hadith domain.

In Islamic education the use of new technologies such as internet, and web technologies is becoming accepted by Muslim educators (Najeeb et al., 2014, Abulatifeh, 2011). The growth of technology and the creation of mass media have good and bad effects on society and on Islam as a religion. The good effects about new technologies are allowing people to interact and work easily. Nowadays, people can browse and navigate through hundreds of Islamic resources on the web (Kadar Muhammad Masum, 2013). Since these resources are available for everybody, some people with little knowledge of Islamic religion and faith start to issue Fatwa's (defined: as the legal opinion or learned interpretation that can issue law and rule pertaining to the Islamic law). To issue a Fatwa without a deep knowledge about Islam, is considered a forbidden action for a Muslim, the Quran states: *"And do not say about what your tongues assert of untruth, "This is lawful and this is unlawful," to invent falsehood about Allah. Indeed, those who invent falsehood about Allah will not succeed"* (Ch.: 16 V: 116).

The internet is a vast resource, as such, it can be a misleading or unreliable resource of information, and it cannot be used as a definitive resource unless it is known as a trusted website run by knowledgeable and qualified Islamic scholars. The adoption of technology comes with certain caveats; there are some websites spreading false and misleading information about Islam and its rulings. This is one of the negative effects technology has had on Islamic knowledge. However, through trusted sources (such as Multaqa Ahl-alhdeeth (Ltd, 2014), and Maktabah AlShamilah (shamela, 2011), the spread of truthful and valuable information has made it possible for people to access sources of knowledge that were previously unavailable to them. In this situation, technology is a great resource for spreading Islamic knowledge and is being utilised by teachers and scholars alike. Technology is being utilised to teach Islamic knowledge to all age groups, the younger learners have access to applications on computer and mobile devices that allow them to learn the basics of the Arabic language and the fundamental principles of Islam. The older generation of Muslim learners have access to vast arrays of reference programs that allow the user to search through hundreds of books in a few second in order to reference the study of certain topic or issue.

2.4. Chapter Conclusion

The Arabic language is considered today the mother tongue of over 300 million people throughout the Middle East and North Africa. Classical Arabic, which is the oldest form of the Arabic language, and it is the language used in the holy Quran, as well as the Hadith, which is the record of the prophet Muhammad statements and actions.

Islam is essentially and strictly linked to the Classical Arabic language, while speakers from different languages follow Islam, Classical Arabic dominates the religion linguistically. Classical Arabic has evolved over time to meet the changing needs of its speakers, it changed from mainly a poetic language in the era before Islam to the language of mathematics, sciences, and medicine (Farghaly, 2003). Furthermore, all other nations where Islam is practiced, people learn to read the Classical Arabic language in order for them to firstly read the Quran and secondly to be able to perform their daily prayers which are the foundations of the Islamic religion. Therefore, it can be said that the 1.7 billion population of Muslims around the world use the Classical Arabic language throughout their daily life to some extent.

Modern Standard Arabic, which is mainly derived from the Classical Arabic language, is considered the official language throughout the Arab world, as it is used in everyday language, in the media, education, and literature. While the colloquial Arabic refers to the regional dialects of the language, which are used in everyday discourse and popular culture media (music, movies, etc.).

The main aim of this research endeavour is to research appropriate methodologies and approaches in order to design and develop an appropriate software (i.e. an architecture for an Arabic CITS, and scripting language), which can deliver a structured tutoring session of Islamic topics to the user, by utilising modern methods of teaching Islamic education. The software (i.e. Abdullah CITS), will encompass modern learning theories and methods (illustrated in Chapter 7), and methodologies in order to maximise the user experience and learning gain.

The main challenges of the designed software (i.e. Abdullah CITS), is that it should cope with both the Classical Arabic language the language of Islamic recourse, as well as the modern standard Arabic the language of modern literature. The developed software (i.e. Abdullah CITS), is aimed at native Arabic speakers; mainly children aged 10 to 12 years old. This is because Arab children at this age, are able to construct coherent sentences in Arabic language, and the children are mature enough to grasp and understand the basic concept of Islam (Numani et al., 2003, Hussain, 2010). The software (i.e. Abdullah CITS), is intended to be an interactive learning aid that can be utilised by the children in order for them to learn the basic topics of Islamic education through recourse with the software.

CHAPTER 3 CONVERSATION AGENT (CA), AND THE CHALLENGES FACED BY THE ARABIC LANGUAGE

3.1. Introduction

Rich and Knight (1991), defined Artificial intelligence (AI) “as the study of how to make computers do things which, at the moment, people do better”. AI has been studied for decades, and has resulted in many useful products such as clinical decision support systems (Neill, 2013), and software engineering development (Meziane and Vadera, 2010), but is still considered one of the most elusive subjects in Computer Science.

Alan Turing, a British mathematician proposed an experiment in 1950 to test a machine/computers ability to demonstrate intelligent behaviour in relation to their conversational ability (Oppy and Dowe, 2011). The method of the test was proposed, to explore the question of whether machines can think. Turing suggested taking a behavioural position, to avoid the difficulty of describing intelligence. From this behavioural perspective, he proposed: can machines do what humans do? (Turing, 1950) . This test proposed by Turing became known as the ‘Turing Test’ which became the industry standard when gauging a computer/software’s ability to converse with a human. The dream of having a machine, which can communicate with humans in natural language, was proposed shortly after the computer was invented. In 1966, Joseph Weizenbaum designed one of the first conversational agents computer program known as ‘ELIZA’, which made natural language conversation with a computer possible (Weizenbaum, 1966). However, ELIZA was not an intelligent piece of software, but was capable of creating the illusion that the agent was actually listening and understanding the user’s utterances and providing intelligent responses, when in fact it was just an illusion. As the field of the conversation agents advanced, further developments were made and this led to the production of ALICE (Artificial Linguistic Intelligent Computer Entity). The knowledge base for ALICE is stored in AIML files. AIML is an abbreviation of Artificial Intelligent Mark-up Language that is a derivative of Extensible Mark-up Language (XML). The ALICE engine was a more refined and sophisticated version of the simpler engine used in ELIZA (Shawar and Atwell, 2002).

ALICE introduced AMIL, which is a PM scripting language. AIML, enables people to input knowledge into chat-bots, which is defined as a software program which interacts with users turn by turn using natural language (Kavitha and Pande, 2013).

In recent times, the field of the conversation agents has advanced much further, and this had led to the development of dialogue/conversational agents that utilise artificial intelligence techniques to converse with the user.

A Conversational Agent (CA) is a software program intended to converse with a human in ordinary natural language (Goh, 2008). Two main strands of Conversational Agents have been researched and developed, which are, 'Embodied CAs' and 'Linguistic CAs'. Embodied CAs are a form of intelligent user interface, that can communicate with a user using verbal and paralinguistic methods (André and Pelachaud, 2010), while Linguistic CA's handle conversation in written or spoken forms (Yin et al., 2010).

This chapter will focus firstly on the Linguistic CA (text-based CA), and the diverse applications implementing the CA. Secondly the different approaches for implementing CAs, and the challenges faced by the Arabic language will be described.

3.2. Conversational Agents

A Conversational Agent (CA) is a software program, which can use a natural interface to communicate with users (Crockett et al., 2011). CA's are intelligent agents that react to human natural language input in the form of a question or request in an intelligent fashion. A CA is considered to be intelligent because it can interpret user input and extract key information that allows the CA to generate an appropriate response, and then send the responses back to the user. A CA also has the ability to reason and pursue a course of action based on its interactions with humans and other agents (Crockett et al., 2011) .

CAs nowadays have become a very popular communication method, and have been employed in many professional fields such as advertising, human resources and so on (Thakre, 2011).

Furthermore, CA's can be applied to many domains such as e-commerce, online customer service centres, virtual training systems and education (Skowron and Paltoglou, 2011). In addition CAs, have been used effectively in many applications, such as database interfaces (Owda et al., 2011), student's debt management guidance (O'Shea et al., 2010), and computerised learning (D'Mello et al., 2010). Conversational agents have also been engaged in spoken or written conversation with students, producing characters in an educational context, covering different domain like mathematics, physics, and foreign languages (Gulz et al., 2011). There are two main types of conversational agent, which have been developed in the last few decades, which are linguistic CA (LCA), and embodied CA (ECA). Conversational Agents, both linguistic and embodied are becoming increasingly common and sophisticated in their communication with humans (Nooraei et al., 2014).

ECA, are defined as agents who have the same properties as humans and are normally represented by some sort of avatar or visual aid to represent a human being (Novielli et al., 2010). They have the ability to recognize, and generate verbal and nonverbal communications with the user.

It is important for most ECA's to provide emotional feedback and exhibit personality in a consistent manner, to make the agent more natural and to meet user's expectations (Callejas et al., 2011) . Embodied Conversational agent (ECA), are an example of an agents that can provide a virtual consultation with a simulated health provider. The ECA interacts with users via simulated face-to-face conversation and utilises human like behaviour such as hand gestures, facial display and gaze (Utami et al., 2013) .

A more recent example of an ECA is Greta, which consider to be a three dimensional ECA. Greta presents a model of a woman to the user by implementing the MPEG-4 standard for virtual character animation (Alès et al., 2012).

Greta can communicate using both verbal and nonverbal behaviours, like gaze, head and torso movements, facial expressions and gestures. Greta was designed to provide some kind of information to the user in certain contexts, to achieve the designed goal through a conversation with the user, and an appropriate addressed plan.

During the conversation, Greta tries to achieve believable human like behaviour to reflect what the agents mind has decided according to the personality and other factors characterized through the social context. In general, Embodied Conversational Agents provide more naturalness than text-based CA for they employ speech, gesture, face expression etc.

The other approach to CA development is Linguistic conversational agent (LCA). LCA's are a type of conversational agent that can handle the communication between user and the CA in mainly textual form. A text based CA enables user to communicate with the agent by sending a natural language text message in response to the text based user input.

The agent will receive the message and send the response back to user through the user interface (UI) (Mao et al., 2012) . The UI contains text boxes for the user to exchange dialogue and receive the responses back from the agent similar to a web based chat software for example MSN, AIM, or mobile text message.

LCA's can also utilise speech recognition, in order to allow the user to speak to their computer and receive a response back in the natural language from the agent. This technology consider a very natural technology since the user can talk to the machine in the same way as they talk to a human(López-Cózar et al., 2011) . Historical examples of LCA's are, ELIZA (Weizenbaum, 1966), ALICE (Wallace, 2009), and InfoChat (Michie and Sammut, 2001b).

The main components that a LCA requires is a language processing engine and a scripting language. The engine processes the user input to try to understand it, and the scripting language is used to develop dialogue scripts that the engine utilises to match the user utterance. However, the most used pattern-matching CA in current days is ALICE. Another example of a CA scripting language is the Pattern Script utilised by the Infochat CA (Michie and Sammut, 2001b). In recent times, many more sophisticated examples of LCA's have been developed. LCA's are very popular these days with many large technology companies introducing virtual conversational assistants, for example Apple with Siri (Sadun and Sande, 2014) and Microsoft with their virtual assistant CORTANA (Gilchrist, 2014). The next section will discuss different approaches for developing, and understanding user input in a text based CA.

3.2.1. Different Approaches for Understanding User Input in LCA

Linguistic CA's have been developed using many different approaches, to understanding the user input and to display/simulate some kind of intelligence in the system during the conversation. These approaches are natural language processing, pattern matching, and short/semantic text similarity. Each of these approaches will be discussed in the following sections.

3.2.1.1. Natural language processing (NLP)

CA's developed using Natural Language Processing (NLP) techniques refer to the process of understandable and interpreting user input (McNamara et al., 2013). NLP based CAs focus on translating user utterances and then determining the best actions to respond to the user. Translating user utterance is considered to be the hardest procedure in NLP, since it is based on a number of grammar rules and list of attribute/value pairs from the conversation to determine the literal meaning of the utterances (Catizone et al., 2010). To respond correctly to a user's utterance, a conversational agent based on NLP must understand user utterance. According to (Goh et al., 2007) , the procedure applied to understand a user utterance is as follows:

1. User utterances spelling checker
2. Full-discourse Natural Language Understanding and Reasoning through Network Based Advanced Reasoning technique.
3. The use of Frequently Asked Questions.
4. The use of Metadata Index Search (searching by keywords).
5. The use of pattern matching.
6. Finally Matching Approach by domain expert.

An example of a NLP based CA is the Textual Conversation Agent for Enhancing Attraction in E-learning (TCA) developed by Mao (Mao et al., 2012). The TCA receives the user utterance, and then processes the utterance in four main phases to understand the utterance and reply with an appropriate response:

1. Phase 1: To normalise the utterance (i.e. to remove the wild symbol, such as £, \$, and #), then attempt to interpret the utterance by processing it (i.e. to extract the semantics of the utterance).
2. Phase 2: Compare the processed utterance to predefined templates of which the semantic ontology is defined. Each iteration between the user and CA is based on the reasoning functionality (Xuetao et al., 2008). The generation of the response, is done by searching in the knowledge database and performs some actions carrying the response information.
3. Phase 3: Concerning with the sematic meaning extracted from phase 1, which is matched to user utterance using the semantic module.
4. Phase 4: The response is generated and delivered back to the user.

TCA as well as other CA's based on the NLP development approach require vast amounts of lexical resources such as WordNet in order to function effectively (Xuetao et al., 2008). These resources are not readily available in the Arabic language as NLP research is scarce and not as well established as NLP in the English language. Therefore, the use of NLP within an Arabic CAs has a number of limitations. Firstly, NLP assumes that the user utterances are grammatically correct, which is often not the case. Secondly, natural language used by humans is extremely rich in form and structure, and very ambiguous. A word might have more than one meaning (lexical ambiguity) or a sentence might have more than one structure (syntactic ambiguity).

3.2.1.2. Semantic Textual Similarity (STS)

The second approach for developing a CA involves the incorporation of Short Text Sentence Similarity (STSS) measures. STSS can be used to measure the semantic similarity between short texts of sentence length, typically (10 -25 words long) (O'Shea et al., 2010). Sentence similarity is a crucial and a prerequisite subtask for many text processing and NLP tasks including text summarization, document classification, text clustering, topic detection, automatic question answering, automatic text scoring, plagiarism detection (Mohamed and Oussalah, 2014).

STSS is an essential method for a various applications and tasks , such as question answering system (Celikyilmaz et al., 2010), and students automatic essay grading (Burstein et al., 2010). STSS was also considered as an algorithm which can be utilised to examine a source text and a possibly detect reused text. This could be applied to check journalistic text reuse or plagiarism text detection (Zesch and Gurevych, 2012).

Deploying a STSS measure within a CA is the most recent approach for constructing Conversational Agents using sentence similarity measures (O'Shea et al., 2008). STSS has been shown to reduce the number of scripted patterns down to a small set of domain specific user utterances (O'Shea et al., 2010). However, the use of STSS in CA'S is still in the early stages of research in the English language and its application in other languages (e.g. Arabic) has not yet been research or tested. There are two well established English language STSS measures that have been for use in conversational agents, these are STASIS (STSS based on lexical database to calculates word similarity) (Shrestha, 2011) and , LSA the Latent Semantic Analysis (Gomaa and Fahmy, 2013, O'Shea et al., 2011b).LSA is well-known technique for measuring the similarity between two sentences and represent the contextual-usage meaning of words by statistical computations applied to a large corpus of text (Chang et al., 2013).

LSA applies a singular value decomposition (SVD) technique to decompose the words matrix (collection of text "corpus") to indicate the occurrence of words in documents. However, the drawback of applying this technique is that the SVD requires a numerical computation, which is demanding both in terms of processor time and memory requirements. In addition the use of the SVD technique considered to be computationally extensive (Gamallo and Bordag, 2011).

STASIS incorporates syntactic information by forming the word order vector for each sentence based on a word sequence and location in a sentence, and calculates word similarity from a structured lexical database (Banea et al., 2013). STASIS also requires vast lexical resources (e.g. WordNet) to function correctly. These resources are not available and still in early stages of development for the Arabic language.

Thus, the implementation of STSS measure in an Arabic CA is not feasible at the current stage of CA development. Furthermore, STSS slows down the processing of user utterances as the use of WordNet in a CA is computationally expensive, thus slowing down the response time that effects the user satisfaction.

3.2.1.3. Pattern Matching Technique

Pattern Matching (PM) is the process of matching a string or a sequence of strings in a knowledge base of rules and their associated scripted patterns, to find all the occurrences of that string in the knowledge base and find the best match (Pradeepa and Sharmila, 2014, Noori et al., 2014). PM plays an important role for developing conversational scripts for CAs. The PM approach tries to find the best matching response to the user input from the stored knowledge. This means a well-developed knowledge base can lead the user to believe that they are chatting with a real human (Shawar, 2011). The PM approach requires the development of extensive conversation scripts, which match key input sentences to find the most suitable scripted output (McNeal and Newyear, 2013). In a PM CA, a human author has to expect all types of utterances that could be entered by the user, then script an appropriate response, and specify PM rules to detect them.

CAs scripts consist of groups of rules that are executed in a well-defined sequence. In certain CA's such as Infochat, scripts are organised in contexts to narrow the topic of conversation.

In some systems such as Adam which is developed by Convagent, scripts are organised according to a tree or graph structure to keep conversation at a given time based around a goal (Latham et al., 2010a). Generally, the scripts are organised in such a way that the engine of the CA can be able to detect the context or topic of the conversation.

By arranging, the conversation scripts/rules through context and sub-contexts the PM process is optimised as the engine can utilise the contexts to know which patterns/scripts should be matched with first.

PM employs wildcards which are symbols used to match a portion of the user's utterance, wildcard characters allows one pattern to be specified that could match several sequences of characters (Baron et al., 2012). The PM technique involves matching key words within an utterance. Therefore, CAs scripts consist of a number of rules containing patterns, themselves consisting of wildcards with different word order, tense, and using synonyms to handle the different ways that the user may type in the utterances. Wildcards in PM can help to accommodate the way that the users are conversing with a CA without having to write more cases. Existing PM methodologies do not require the utterance to be grammatically correct or the input to be complete (Hijjawi et al., 2014). Most of the current CAs implements the pattern matching approach, as it is considered one of the best methods to work with an extended dialogues system(O'Shea et al., 2011a). However, there are challenges and drawbacks to the PM approach of CA development. Mainly the time consuming and costly nature of scripting (O'Shea et al., 2008).

The PM methodology requires a large number of scripts to be stored and organised in a knowledge base in order for the CA to be able to match with the user utterances. All scripts have to be scripted by a human, thus taking a very long time and a great deal of effort to compile a functional knowledge base. The CA intelligence is limited by its knowledge base, meaning the larger the scripted knowledge base the more intelligence the CA has to utilise in the conversation with the user. Moreover, a further drawback of the PM approach is the maintenance and upkeep of the scripts, changing or amending a script can affect other scripts, potentially having negative effects of the whole knowledge base. PM algorithms have been used successfully in the development of many CAs such as ADAM, Infochat and ALICE. Successful PM text-based CAs will now be reviewed.

3.2.1.3.1. ELIZA

Eliza is considered to be one of the earliest chat bots developed by Joseph Weizenbaum (1966-1967), which makes natural language communication with a machine possible (Weizenbaum, 1966).

Eliza is designed to act as therapist, by redirected the questions that have been asked by the patents from the dialogue back to the patent, and that will give the illusion of understanding to the users by the Eliza's chat bot (Heller et al., 2005). Eliza was developed based on the pattern matching technique, by using a number of rules and associated patterns stored in the knowledge base of the Eliza program. The knowledge base of Eliza is considered to be the heart of the program, initially the user's input is passed through a number of procedures to break down the utterance into simple understandable units, and then to find the best match in the Eliza knowledge base (Shawar and Atwell, 2002). Eliza uses a number of strategies to keep the conversation on going, such as using fixed phrases if no keyword is matched (i.e. very interesting, please go on, etc.). However, when Eliza was released, there were a few patients who believed that they were talking to a real therapist, spending a couple of hours describing their problems. While in actual fact all of Eliza's responses are extracted from user utterances and simply adapted to carry on the discussion (Shawar and Atwell, 2007a). Eliza scripts uses a number of decomposition and re-composition rules. A keyword can have more than one decomposition rule (Sterner, 1996). For instance, the keyword "Your" in the user utterance "what is your name?" has a number of possible decomposition rules as follows:

1. Rule1: YOUR NAME
2. Rule2: YOUR COLOUR
3. Rule3: (*) YOUR (*)

In the example "What is your name", the keyword will fail to match with Rule1 and Rule2, and it will match with Rule3 "(*) YOUR (*)". In rule three the first symbol (*) indicates any number of words comes at the beginning of the utterance before the word "Your", while the second symbol (*) indicates any number of word coming after the keyword. As a result, the response from ELIZA's is (My name is Eliza).

Eliza had a number of drawback such as, the details given by the user are forgotten or not cached in memory, thus as the conversation went on there was no action from ELIZA for the user repeating themselves or recalling something they had previously discussed (Shawar and Atwell, 2007b).

Most of the Eliza's responses, were simply rephrasing the user utterances as questions, and delivered back to the user, which gave the user an impression of a lack of intelligence from ELIZA.

3.2.1.3.2. ALICE

ALICE (Artificial Linguistic Internet Computer Entity) is a text based CA, which can converse using natural language (Wallace, 2009). ALICE is considered one of the most common CA, and it has been awarded the Loebner Prize three times in 2000, 2001, and 2004 (Deryugina, 2010). The brain of ALICE consists of 41,000 elements called categories; each category consists of an input or a question, which called pattern, and an output or an answer, which called template. Artificial Intelligence Mark-up Language (AIML) is built on the standards of the Extensible Mark-up Language (XML), to define the response message to question (Freitas et al., 2014). The patterns categories are held in a tree structure by an object called the Graph master, which implements a pattern storing and matching algorithms for efficient pattern matching. ALICE modelling the conversations with the user through the stimulus-response approach, which interpret each statement read by the chatterbox and then processed it in software called an interpreter (Marietto et al., 2013).

The interpreter used wildcards (i.e. "*", and "_"), to replace the string of words or sentences, and gives the higher priority for the patterns that contains "*" than the pattern contains "_".

According to (Wallace, 2001), the utterance can be visualized as a kind of path built by a series of links and nodes in the knowledge base of the ALICE's Artificial Intelligence Mark-up Language. The conversation is spilt into categories, which consists of a list of statements, which contains an input pattern and a reply/response template. ALICE's AIML scripting language begins by "<alice>" tag and end by "</alice>" tags, and has many categories. Furthermore, the AIML in ALICE, has three types of categories: atomic categories, default categories, and recursive categories.

Figure 3.1 , shows an example of AIML, which include a default category (a category that contains a pattern that has a wildcard "*" or "_").

The asterisk in Figure 3.1 will let the pattern to match with any input following the sentence “I NEED HELP”. So if the user entered “I NEED HELP TO UNDERSTAND THE MEANING OF AIML”, the user utterance will match with the pattern “I NEED HELP *”, and then ALICE will reply with the template “Can you ask for help in the form of a question?”.

```
<alice>
.....
<category>
<pattern>I NEED HELP *</pattern>
<template>Can you ask for help in the form of a question?</template>
</category>
.....
</alice>
```

Figure 3.1 Example of AIML format (taken from A. L. I. C. E. and AIML Documentation)

The second type of AIML category is called Recursive category (a category that maps user input to other input). The recursive category tries to simplify the language or to identify synonymous patterns, as many inputs can share with the same response. Figure 3.2 show the recursive category calling the pattern matcher recursively using <SRAI> and <SR> tags. The input “GOODBYE”, in the following figure has a number of synonyms (such as “BYE”, “BYE BYE”, “GOOD BYE”, and so on); recursive category will then map the input to the same output “GOODBYE”.

```
<alice>
  <category>
  <pattern>BYE BYE</pattern>
  <template><srai>GOODBYE</srai></template>
  </category>
</alice>
```

Figure 3.2 Recursive category example of AIML format (taken from A. L. I. C. E. and AIML Documentation)

The Atomic category are the third category type in AIML, and it is defined as the category with the patterns that do not have wildcards. Figure 3.3, show that if the user input was “10 Dollars”, then ALICE will deliver the response back to user which is “Wow, that is cheap.”(Shawar and Atwell, 2005).

```
<category>  
<pattern>10 Dollars </pattern>  
<template> Wow, that is cheap. </template>  
</category>
```

Figure 3.3 Example of AIML format (taken from (Shawar and Atwell, 2005))

The weakness of ALICE CA are restricted to the knowledge that is hand-coded in their files (Shawar and Atwell, 2005). In addition, the ALICE architecture does not maintain a “belief model”, so it has no way of avoiding logical inconsistencies across the chatting session (such as repetition).

3.2.1.3.3. Infochat

Infochat is a commercially developed conversational agent developed by ConvAgent Ltd (2005). Infochat implements a pattern matching approach using more sophisticated scripting language known as Pattern Script (Michie and Sammut, 2001a). Infochat has its own scripting language, that uses a form of pattern matching organised into a number of contexts/topics consisting of a number of rules which themselves consist of a number of patterns and a stimulus response pairs in the CA’s knowledge base. Each context represents a state or topic of conversation. The contexts are further divided into sub-topics. The subtopics are the rules that belong to the main context, and are linked to scripted patterns that the user utterance can be matched with in order to fire that particular rule.

The Pattern Matching approach implemented in Infochat includes more features than ALICE’s AIML has, such as the ability to implement a variable that is used by the engine to calculate the matching strength of an utterance to particular pattern. Figure 3.4 Illustrate a part of the scripting language used by the student debt Advisor ADAM (ConvAgent, 2011), which has been designed to help students who have debt problems. The figure shows the rule called “No_Money”, which includes a number of patterns to match with the user utterance and a response. The patterns contain the wildcard (*) that matches any number of words, which can be for example “I have no money” or “I don’t have any cash”. In addition, each rule has an activation level (in this example “A: 0.5”), which is used to calculate the rule strength.

The rule that has the highest activation level will fire and the response will delivered to user (i.e. "I'm sorry to hear that").

```
<No_Money>
A: 0.5
P: * money
P: * cash
P: * dosh
P: * funding
R: I'm sorry to hear that
```

Figure 3.4 Part of Scripting Language taken from (Adam Script (Michie and Sammut, 2001a))

Infochat uses a complex algorithm/formula that utilise the features in the scripting language in order to calculate the matching strength of the pattern to the user utterances. The algorithm takes into consideration several key parameters variable to calculate the rule strength such as activation level, pattern length, trailing and leading symbols and white space. Infochat also has the ability to deal with cases where several rules fire or have the same matching strength. This is called conflict resolution and Infochat handles this by giving priority to rules in the current topic of discussion. Infochat has some limitations and disadvantages. The main limitation is that the knowledge is limited to the ability or expertise of the scripter. However, through effective knowledge engineering this problem can be overcome. A problem as not all the knowledge of a domain from a human expert can be transferred to a knowledge base in remains.

Therefore, the knowledge base is not always a full representation of the conversation domain. Furthermore, Infochat is implemented using outdated technology, it stores its scripts in texts files, which makes editing and searching scripts for the purpose of maintenance difficult.

The Abdullah CITS, presented in this thesis is modelled based upon the principles introduced by the Infochat CA.

However, as Infochat is an English CA a number of adjustments and a new features must be developed in order for the Arabic language to be implemented within this type of system.

This includes the development of a substantially different scripting language designed specifically for the Arabic language chapter five (section 5.2.1).

3.3. The Arabic Language and its impact on CA development

The research and development of Arabic CAs is a relatively new in the field of conversational agents. There are many challenges surrounding the integration of the Arabic language into a CA. These challenges include the complexity of the morphological system, non-standardization of the written text, ambiguity, and lack of resources, such as an appropriate Arabic WordNet for classical Arabic language (CAL).

This section explores the current state of Arabic language research and its implementation within CA's. The Arabic language consists of a number of features, which could affect the design of an Arabic CA. These features can be categorized into Arabic language characteristics, and Arabic grammar.

These language specific features will be highlighted in the followings sections, along with how the features could potentially effect the development of an Arabic CA.

In addition to this, the challenges of the Arabic language poses to the different CA development approaches are also investigated, and finally a review of existing Arabic CAs is conducted.

3.3.1. Arabic langue characteristic

The Arabic language has 28 letters and has many different written forms depending on their position in the word. Arabic letters are written in four positions: initial, medial, and final position both connected and unconnected (Frangieh, 2012) as shown in Figure 3.5. Arabic and English languages share many features of writing such as the punctuation marks, spaces to separate words, and special symbols.

However, Arabic differs from English in its use of vowels, the vowel sound in Arabic is indicated by diacritical marks that appear above or below the letter in order to give the vowel sounds (Abbas, 2011).

Final		Medial	Initial	Independent
Unconnected	Connected			
ا	آ	آ	أ	آ
ب	ب	ب	ب	ب
ت	ت	ت	ت	ت
ث	ث	ث	ث	ث
ج	ج	ج	ج	ج
ح	ح	ح	ح	ح
خ	خ	خ	خ	خ
د	د	د	د	د
ذ	ذ	ذ	ذ	ذ
ر	ر	ر	ر	ر
ز	ز	ز	ز	ز
س	س	س	س	س
ش	ش	ش	ش	ش
ص	ص	ص	ص	ص
ض	ض	ض	ض	ض
ط	ط	ط	ط	ط
ظ	ظ	ظ	ظ	ظ
ع	ع	ع	ع	ع
ف	ف	ف	ف	ف
ق	ق	ق	ق	ق
ك	ك	ك	ك	ك
ل	ل	ل	ل	ل
م	م	م	م	م
ن	ن	ن	ن	ن
ه	ه	ه	ه	ه
و	و	و	و	و
ي	ي	ي	ي	ي

Figure 3.5 Arabic Letters, with its position in word

Arabic characters are laid out in right to left order, and each letters changes its shape depending on its position in the word. Another fact about the Arabic language is that the language does not support capitalisation of proper nouns such as (name of a person, places, date, event, etc.).

The morphological richness of the Arabic language leads to an inability to understand or recognise the user utterance for CAs based on Arabic language. Since the scripter of the Arabic CA has to cover all expected keyword's changes to meet different cases of the scripted keyword such as singular/plural, or masculine/feminine.

Furthermore, additional challenges are faced when trying to extract information from MSA and then apply that information to provide relevant responses related to the CAL, which is even more complicated in its grammar and structure. Therefore, it is not viable for an Arabic CA to be developed using methodologies of CA development that were used specifically in the English language.

Through this research, it is required in order to develop a novel CA engine and architecture that can bring together the MSA and CAL while dealing with the language unique features and challenges of Arabic in both forms. Motivated by the technical facts, which have been specified in section (3.3), the main drivers and motivation behind further research into the Arabic language within the CA context are:

- There has been an increasing interest in Arabic language development because it is the main language of the holy book of the Muslim Quran (Nimer, 2014).
- The technology, advances the teaching of the Quran, could benefit from having new sources for teaching the basics of the language as well as having a software that could be used as a source of reference and as a learning tool.
- Traditional Arabic grammar is characterized by a large set of rules that serve well for various complexities of the language (Badawi et al., 2013).
- Islam and the Quran have helped to preserve classical Arabic from decay (Ibrahim, 2011). Therefore, to continue that preservation, utilising modern technology will help in its future preservation by making it more accessible and teaching more people about the Quran.

3.3.1.1. Arabic language grammar

The Arabic grammar has two main categories, which are the Arabic morphology, and the Arabic syntax (Al-Muhtaseb and Mellish, 1998). Implementing Arabic grammar in a CA will help to reduce the great morphological diversity per word, by understanding the initial meaning of sentence (Farghaly and Shaalan, 2009).

There is currently a lot of demand and interest in linguistic processing tools for the Arabic language (like lexicon, corpus, dictionary), but the tools for the genre of classical Arabic language remained relatively unexplored (Atwell et al., 2011).

3.3.1.1.1. Arabic Morphology

Arabic morphology, or word structure is the process of understanding the meaning of the units of the language, whether they be words or parts of words, such as affixes vowels, and root-based systems (Sawalha, 2011).

The ambiguity in the Arabic morphology is a famous problem because of the richness and complexity of the Arabic language.

Arabic language is a language that has the same orthographic (spelling) form, although the pronunciation is different due to the use of diacritics. The diacritics are omitted from modern standard Arabic language written forms (Attia, 2008).

In Arabic language words can be changed from one form to another form or to several forms, for instance the word "يَعِدُّ / *yu'id*" (to promise), the word "يَعُدُّ / *ya'uddu*" (to count), and the word "يُعِدُّ / *yu'iddu*" (to prepare) are showing a different meaning of the words, and presenting a challenge to any kind of computational processing.

Diacritics play an important role in Arabic language, and ignoring diacritics in written Arabic text might confuse the reader especially when the words are not related to the context.

Generally, when Arab people talk they use diacritics, and they ignore diacritics in written modern standard Arabic language.

3.3.1.1.2. Arabic Syntax

Arabic Syntax, is the science of the Arabic language, which deals with how to identify the grammatical positioning of the three parts of speech: noun, verb, and Particle (Khoja, 2001). A noun in the Arabic language is a name or a word that describes a person, thing, or idea. It could be definite or indefinite and can be subcategorized by the number (Singular, Dual, Plural), and gender, while verbs are classified based on the root word (El Hadj et al., 2009).

The Arabic language is based on a root to generate the language's words; a root is the initial form of the word that cannot be analysed further (Danks, 2011). Most verbs and nouns are derived from 3 or 4 letter consonants, and in very rare cases from 5 letters consonants (Darwish, 2002). In the Arabic language most verbs and nouns are derived from 3-letter consonants (Awajan, 2011). Table 3.1 shows an example of a 3-letter Arabic root “درس” D-R-S.

Arabic word	Translation	English Translation
دَرَسَ	Darrasa	To teach
دَرَس	Dars	lesson, class
مُدَرِّس	Mudarris	Male teacher
مُدَرِّسَة	Mudarrisa	Female teacher
دَرَسَ	Darasa	To study
دَرَسَا	Darasaa	To study (dual, masculine)
دَرَسْتَا	Darastaa	To study (dual, feminine)
دَرَسْنَ	Darasna	To study (plural, feminine)
دَرَسُوا	Daraso	To study (plural, masculine)
مَدْرَسَة	Madrasa	School
مَدَارِس	Madars	Schools
أَدْرِسْ	Iudres	Study (Imperative to male)
أَدْرِسِي	Iudresee	Study (Imperative to female)
أَدْرِسُوا	Iudrosu	Study (plural, masculine)
أَدْرِسْنَ	Iudrsna	Study (plural, feminine)

Table 3.1 3-letter Arabic root example

As natural language processing is concerned with understanding the meaning of the sentence, the inherent richness of the Arabic morphology poses many challenges. The Arabic language can have a large number of affixes (prefixes, infixes and suffixes), which can be added before, inside, or after a root to generate words that are more meaningful.

Furthermore, the Arabic language is extremely affected by gender, number, and case. A single Arabic word can represent a completely English sentence like *وَبِدْرَاسَتِهِمْ* /wabiDrasatihm/ (and with their study).

The complexities in the morphology in the Arabic language could further increase the effort for designing and implementing an appropriate scripting language and engine to deal with Arabic language morphology such as to cover the complex structure of Arabic morphology.

3.3.2. Linguistic Conversational Agents Implementation Approaches

In the last few decades, the Arabic language in a technological sense has shown an increasing importance in the modern world. The Arabic language puts forth many challenges for computer science researchers such as, natural language processing in Arabic (Habash, 2010), and Arabic word stemming (Sembok and Ata, 2013). There are many different approaches for developing linguistic CA's, these approaches will be reviewed with along with the challenges that arise when implementing the Arabic language in a conversational agent.

3.3.2.1. CA based on Natural Language Processing (NLP)

The classical Arabic language is formally written using characters and diacritics. Diacritics are used to minimize misinterpretations and ambiguities of the Arabic sentences. However, most of the written Arabic text is lacking in diacritics except for the religious domain such as, the Quran, which use both the diacritics and dots system to allow non-Arabic Muslims to read the Quran as it was originally written.

Traditionally NLP based CA would have to understand the user's input (Laorden et al., 2013). Understanding the user input means recognising the expressed information it contains. the Arabic language is very rich language and the words carry a lot of information that cannot be found in any other languages (Boubas et al., 2011).

However, the possible use of NLP within Arabic CAs (to the researchers knowledge, no Arabic CA has been developed using NLP technology), has a number of limitations. First, user utterances are expected to be grammatically correct, which is often not the case. Second, natural language used by humans is extremely rich in form and structure, and very ambiguous. A word might have more than one meaning (lexical ambiguity) or a sentence might have more than one structure (syntactic ambiguity). To illustrate this notion, a pair of sentences was collected from Arabic syntax book written by Al- Du'ali (al-Du'alī et al., 1975), as an illustrated in Figure 3.6.

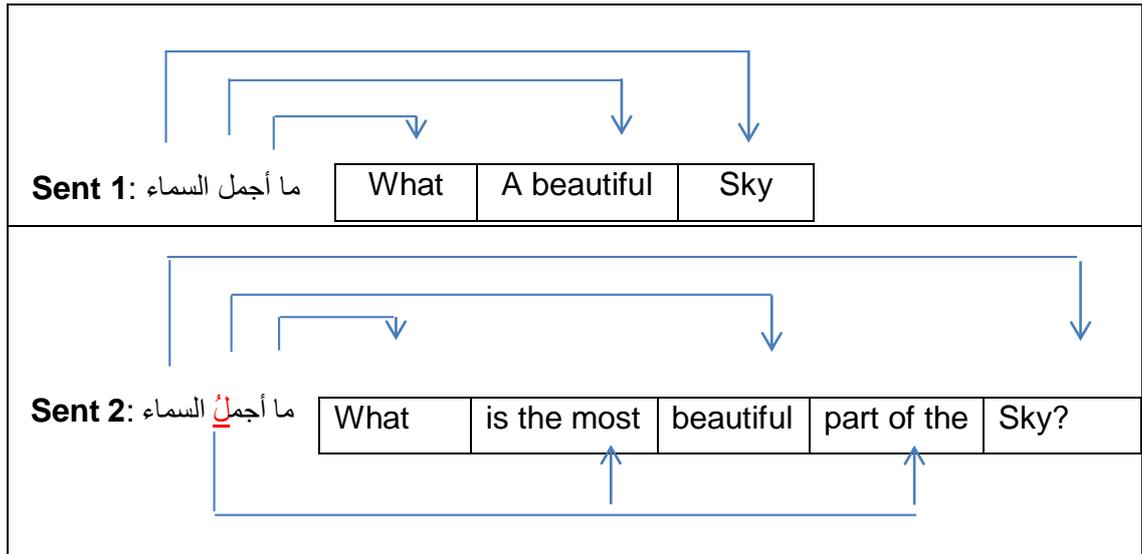


Figure 3.6 Two sentences from Al-Du'ali Arabic Syntax book

In Figure 3.6 both sentences have the same words and structure, the only difference is the Dhmmah (is a small curl-like diacritic placed above a letter to represent a short letter /u/) that has placed above the end of second word in the second sentence (Sent2). According to the Arabic grammar the first sentence is an exclamatory sentence while the second sentence it is an interrogative sentence (Ryding, 2005). However, the richness of the Arabic morphology and grammar makes it difficult for an NLP based CA to understand user utterances. A misunderstanding of a user utterance during the conversation might cause the system to fail. For these reasons, the NLP approach was considered not be appropriate to build a CA based on Arabic language.

3.3.2.2. CA based on Short Text Sentence Similarity (STSS)

As discussed in section (3.2.1.2), to build an Arabic CA based on STSS measures will introduce many challenges, as Arabic is a language of rich and complex morphology, both derivational and inflectional.

To illustrate these challenges consider the example in Figure 3.7, where sentences 1, and 2 can be very ambiguous without diacritics. A writer can easily resolve any ambiguity by using proper diacritics, so by putting 'Dhmmah' at the end of the first word in the first sentence and putting 'Fatha' (is a small diagonal line placed above a letter to represent a short /a/) at the end of the first word in the second sentence would solve the ambiguity between these two sentences.

Another fact about Arabic to take into consideration is that the language has neither capital letters (for proper names: the names of people, countries, cities, names of months, etc.). This increases the inability to detect proper names and then classify them, for instance sentences 4 and 5 are identical sentences where sentence 4 illustrates some facts about Arabic calendar year that the month of Ramadan comes straight after the month of Shaban. While sentence 5 only describes that one man has come and the other is gone (where Ramadan and Shaban are the two men's names). Using a STSS measure in a CA could be more effective as it reduces the scripting effort to a minimum by replacing the scripted patterns by a few natural language sentences in each rule (O'Shea et al., 2008).

Sent1	دار محمد في المدينة	Sent4	جاء رمضان وذهب شعبان
	Muhammad's house in the town		the month of Ramadan is came and the month of Shaban is gone
Sent2	دار محمد في المدينة	Sent5	جاء رمضان وذهب شعبان
	Muhammad take a round in town		Ramadan is came and Shaban is gone (Where Ramadan and Shaban are a man's name).

Figure 3.7 Identical sentences with different meaning

However the lack of research in this area with, currently only one prototype semantic CA having been developed in English which uses STSS and English WorldNet (O'Shea et al., 2009), while the research into the development of STSS for Arabic is still in the early stages. In addition to that there are no existing similar Arabic STSS measure (Almarsoomi et al., 2012), and that led the researchers adopting the traditional approach for building CA which is the use of Pattern Matching technique (PM).

3.3.2.3. CA based on Pattern Matching (PM)

Linguistic CA scripts are organised into sets of contexts that manage a particular part of a conversation, each of these contexts has a number of related rules pertaining to a particular topic of the conversation, as illustrated in section (3.2.1.3).

During the conversation, there is always a current context to represent the topics. Therefore, user utterances which are based on the classical Arabic language that fail to match with scripted rules in the knowledge base causes the CA to deliver responses not relevant to the conversation topic. In addition, as with English CA's, the large amount of scripted patterns makes the maintenance a very difficult and time consuming process.

The utilisation of PM techniques to develop an Arabic CA have been explored in the past (Hijjawi et al., 2014).

PM is considered to be an ideal solution for a CA based on the modern standard Arabic language, because it solves the complexities of understanding the Arabic language, by matching the utterance with a set of scripted patterns, ignoring the diacritics and semantics of the Arabic word's. Building an Arabic CA that is based on PM is a good technique to solve the problem of the ambiguity of the Arabic language. The system should be well designed to handle the user utterances in the Arabic language in order to demonstrate a level of intelligence, by providing suitable responses to users.

For example, to make the system understand and respond appropriately for each of the sentences, that are illustrated in Figure 3.6. The system should be able to recognise the current context about the conversation and respond accordingly. The PM knowledge base/scripts can contain both MSA and CAL in order to recognise both versions of the language. However, these diacritical marks are removed when communicating in Modern standard Arabic in order to increase the speed of reading and writing.

3.3.3. Review of Arabic CAs

Arabchat (Hijjawi et al., 2014), is an example of CA that is based on the Arabic language, and it is designed to help students to make enquiries about Universities and general information about Jordan.

Arabchat was the first Arabic CA developed using the pattern matching approach. It was modelled based upon the Infochat CA and scripting language, and was specifically designed to handle modern standard Arabic language.

The main weakness of Arabchat is that it is only suitable for MSA, which limits the domains that it can be applied to. Secondly, there are a vast amount of scripted patterns, which makes maintenance a very difficult and time-consuming process. Another example of an Arabic Chatbot is the Quran Chatbot developed by Abu Shawar (2011). Quran Chat Bot can accept Arabic language questions related to Islamic issues and then extract the most relevant answers to the questions from the Quran.

One of the weaknesses of the Quran Chatbot is that it can only replay to the user by responses, which contains only verses from the Quran. In addition to that, the developed Quran Chatbot generate an answer and send it to user, which is often not related to the question that was asked by the user. The Quran must be studied in order to find answers to related questions as the answer to a particular topic or subject could lie in different chapters throughout the Quran.

Abras et al. (2012), have devised an intelligent conversational agent that can communicate with users by text dialogue in modern Arabic language. The Arabic agent has been deployed online on the Syria airlines website during 2012. Users were able to query certain flights and request booking on these flights. User utterances had to pass a number of processes before the responses was delivered back to the user.

These processes started by classifying and analysing the utterances by using an Arabic language stemmer algorithm (i.e. Khoja analyser (Sawalha and Atwell, 2008)). After the analysis process, the agent stores the user request/query in the user profile, to collect the basic booking information. Afterward the agent will display the results about the flight to user and then the agent would wait for a new request from the user.

Each of the examples discussed above have been developed to handle one of the versions of the Arabic language (MSA). An effective Arabic CA would ideally be able to handle both MSA and CAL in order to be considered robust and effective. However, no current CA or dialogue agent is able to cope with both versions of the Arabic language (MSA, and CAL). Therefore, a research is required on how both versions of the Arabic language can be implemented into a functional CA in order to recognise and respond to CAL as well as MSA.

3.4. Conversational Agent Evaluation Methodologies

The growth of linguistic CA is limited by the shortage of existing evaluation methodologies, especially in measuring the performance and user satisfaction. Existing evaluation procedures focus on the embodied CA, and very little attention has been paid to the evaluation of the text based CA. This section provides a brief review of evaluation strategies that have been used with linguistic CAs. Typically linguistic CAs are evaluated either by distributing a questionnaire to the users trying to gauge and capture their subjective assessment of using the CA or by objectively analysing the resulting dialogue. To carry out the subjective evaluation a questionnaire is typically administered to the user after using the CA.

The user is asked to fill out the questionnaire according to their experience and interaction with the CA. The questionnaire aims to evaluate several aspects of the CA, including user interface, usability, naturalness, the applied domain coverage, and general user satisfaction (Silvervarg and Jönsson, 2011).

The objective evaluation can be done without the questionnaire; this evaluation is based on analysing the log file of the conversations to evaluate a CAs (Walker et al., 1997). Log file are another tool used in CA evaluation, which are often used initially during the development stage of the CA for debugging and improving CA scripts , allowing adjustments to rules and patterns to ensure that the best fitting rule fires.

Arabchat CA (Hijjawi, 2011), was evaluated objectively using two approaches namely the Glass box approach and the Black box approach.

The black box approach aims to evaluate the system as one component and focuses on measuring the performance of the system. The performance measured in Arabchat, by analysing the quality of Arabchat responses and the cost of the achievement (by measuring the number of matched utterances during a conversation). The glass box approach adopted by Arabchat aims to evaluate the individual components of the CA by utilising information about the conversation between the user and the CA. This information is recorded in a log file, which contains information such as, the scripting language, type of utterance, and the applied domain coverage.

A log file was used in the Arabchat CA to record the conversation, and other variables such as the ratio of matched utterances to the total utterances in context. These variables were used specially to evaluate the performance of the Arabchat CA. However, using this technique is debatable because it overlooks some key issues surrounding CA development. For example, this method does not allow the evaluation of the overall robustness of the system i.e. building a strong knowledge engineering platform for the specified domain to make the CA seem more intelligent by covering more contexts. Furthermore, not all the scripted patterns will give a full view of the CA domain (i.e. number of contexts and the rules for a particular context) this is where a strong knowledge engineering platform is need it to script the domain. PARADISE (PARAdigm for Dialogue System Evaluation), is a general framework used for evaluating spoken CAs (Walker et al., 1997) . PARADISE is the first objective evaluation for a linguistic CA, and the general for PARADISE is to maximize user satisfaction through maximizing task success while minimizing dialogue costs (Hjalmarsson, 2002). User satisfaction rules characterize the overall quality of the system, and are causally related to task success and dialog costs, i.e. efficiency and quality of the dialog (Schmitt and Minker, 2013). PARADISE uses a set of parameters to assess the costs of a dialog, while the dialog efficiency is measured by counting the number of turns until the task is completed (Engelbrech et al., 2009). According to (Walker et al., 1997), PARADISE uses a number of metrics such as the Subjective measure (to measure user satisfaction), Qualitative measure (to measure agent response delay, inappropriate utterance ratio, etc.), and Efficiency measure (to measure number of utterances, dialogue time, etc.). In relation to the evaluation of the Arabic CA, PARADISE is the only known methodology used to evaluate the Arabic CA. However, there is still no formal benchmark/framework available to evaluate CAs in recent times.

3.5. Chapter conclusion

This chapter has defined conversational agents, which are software programs that allow people to communicate with a machine using natural language input.

ALICE, ELIZA, and Infochat are an examples of linguistic/text-based CA's that adopt the pattern matching (PM) approach which can handle the utterances that are not complete or contain spelling mistakes from the user.

PM as well as two other approaches like Natural Language Processing (NLP), and Short Text Sentence Similarity (STSS) have been described and the justification for not implementing them in the Arabic language have been provided. The Pattern matching approach is considered the most appropriate method for handling and implementing the Arabic language with a CA.

The ambiguity and lack of resources of the Arabic language have been explored and discussed.

The PM approach helps to solve the Arabic language ambiguity by classifying the topics of conversation into a number of context. Each context consists of rules and an associated patterns (to match with user utterances), and an appropriate responses. New scripting language specifically designed for the Arabic language based on the principles of English scripting language will needed to be developed in order to construct an Arabic CITS.

Developing an Arabic CA that can handle both modern standard Arabic (the language that used in a daily communication by people), and the classical Arabic (the language of religious sources), could make the Islamic education more effective in promoting a deep understanding, as well as showing a modern and intelligent method for learning.

The adoption of the PM approach is seen as the most suitable method for developing an Arabic CA as it allows the mitigation of most of the challenges posed by both versions of the Arabic language. In addition, PM is considered an appropriate method to overcome the challenges faced by the Arabic language such as the ambiguity, complexity of the grammar, structure and morphology.

Developing an Arabic CAs that can interact in both modern and classical Arabic language will make the user experience more natural, and easier. A CAs that could actively discuss problems and solutions using natural language, as well as providing an answer that only an expert human tutor can do, could widen accessibility to Islamic education, furthermore it can be used as a tutoring aid in face-to-face learning.

**CHAPTER 4 INTELLIGENT TUTORING SYSTEMS AND THE METHODS
OF LEARNING****4.1. Introduction**

Intelligent Tutoring Systems (ITS) are adaptive educational systems that employ intelligent technologies to provide individualised instruction, by adapting students' skill level closely to individualized lesson provided by the system (Oxman et al., 2014).

Recently, there has been a lot of research into computerised educational systems such as ITS (Sottolare et al., 2014). ITS systems offer many benefits and advantages to learners/students for example they are available 24 hours and can be accessed by the learners at their own convenience. Furthermore, ITS systems are able to adapt to the students to offer individualised instruction, feedback and guidance. Additionally, ITS are more cost effective than human one to one tutoring making them accessible to a wider audience.

In recent times, ITS have been combined with CA to offer a more interactive user experience through natural language communication with an ITS (Muhammed SANI, 2014). This chapter outlines the concepts of ITS and their development approaches, as well as learning methodologies and how they can be applied to ITS.

4.2. Intelligent Tutoring System

Intelligent tutoring systems (ITS) are computer based learning systems that are used by students in order to learn about a particular subject. ITS can adapt to students' knowledge and skills, and can provide the necessary feedback when mistakes are made and to present new topics when the student is ready to learn (Ghadirli and Rastgarpour, 2013a). The main goal of an ITS, is to build computer-based tutors that achieve the effects of personalised learning with a human tutor. Recently, ITS have started to utilise artificial intelligence (AI), in order to make the tutoring more natural by mimicking human interaction. ITS are generally developed to focus on teaching a particular subject or topic to the user/learner for a particular domain (Abbas et al., 2014).

ITS have become prominent in recent times, through the development of an online applications (Ghadirli and Rastgarpour, 2013b). Intelligent Tutoring Systems extend traditional content-delivery computerised learning systems by adding intelligence to improve the effectiveness of a learner's experience. This normally involves personalised tutoring by using factors such as learner's knowledge, emotion or learning style to alter the sequence and style of learning material (Seniut, 2012).

Several commercial software companies are developing intelligent tutoring systems, as well as many educational researching institutions using and implementing these intelligent tutors in school systems (Woolf, 2010). However, the advances of the Internet now allow intelligent tutoring developers to provide access to powerful and useable programs via web-based clients anytime, anywhere at a much lower cost. The Internet is moving a system traditionally constrained by space, time and cost into a more efficient knowledge and learning-driven industry (Woolf, 2010).

The field of ITS aims to create autonomous tutoring software that is able to mimic a human tutor. The optimal aim would be to replace the human tutor with an ITS (Jaques et al., 2014). However, until now this has not been possible. It remains one of the definitive development goals to make ITS more like human tutors or to even eventually replace them (Giuffra et al., 2013).

4.2.1. History of ITS

In order to understand the purpose of an ITS it is important to mention the use and adoption of technology in educational contexts. Accordingly, it is necessary to analyse the interaction between education and technologies. The technological support material such as software and computer aided design have always been present in the educational context. This section will focus on outlining the developments of ITS over the last sixty years.

Simon (Buchanan, 2005) ,is considered as the founder of the classical Artificial Intelligence (AI). Simon's (Simon, 1969), work stemmed from the hypothesis that the human brain and the computer had a common functional description.

Consequently, a collaboration between cognitivist learning in education and technological research was born with the aim of developing new and effective ways of combining technology with education.

During the early stages of ITS research and development it was found, that it was essential for ITS to adopt AI techniques. ITS received a strong input from the mutual need of AI and of the educational system to find successful applications. That could demonstrate the power of Intelligent Computer-Aided Instruction, by improving instruction in the provision of “effective tutoring for every student, tailored to user needs and pace of learning (Nkambou et al., 2010). This led to a standardised framework/architecture to be developed for the implementation of ITS.

The traditional ITS architecture consists of three main models/components which are, the student model, the tutor model, and the domain model (Boukil, 2014). As technology advances, an additional fourth component/model was introduced into the basic architecture. The fourth model was the “user interface”, as a result, these four components now represent the standard for ITS construction, also in authoring tools which have been produced to help instructors to develop ITS in the educational field. By the 1990s and through to the present day, the general architecture of ITS has remained unchanged (McDonald et al., 2013).

Recently, the interest of the ITS research community moves from the disciplinary domains to educational strategies which support both the student in the learning process and mainly in the evaluation of that learning process from the objective world and subjective action (cognitive and practical) (Szafir and Mutlu, 2013). Furthermore, greater emphasis has been applied to the monitoring process, assessment and representation of the built knowledge. As well as methodologies which offer ITS plenty of teaching strategies among which to choose from to best suit the learner (Paviotti et al., 2012).

A recent example of ITS development was led by the intelligent tutoring systems group at the University of Saarland who have been developing the web-based ITS called ActiveMath (Gogvadze, 2011). ActiveMath employs a number of AI-techniques to realize adaptive course generation, feedback, interactive exercises, and knowledge representation.

In the last few years dialogue systems or conversational agents (see Chapter 3), have begun to appear and some ITS have utilised and incorporated this technology into the system architecture to allow natural language dialog between the student and the ITS. For example, Auto-Tutor (D'mello and Graesser, 2012), and CarmelTC (Rosé et al., 2003), and Oscar CITS (Latham et al., 2014).

As mentioned previously ITS incorporate four main components, and the next section will illustrate the ITS architecture with their functionality individually and then by way of their integration.

4.2.2. ITS Architecture

ITS typically have four main components, which are the domain model, student model, tutor model, and interface model as shown in Figure 4.1 (Ahuja and Sille, 2013). These components work together to monitor the learner's performance during the tutoring session and to respond with appropriate instructions according to the learning performance during the tutoring session. These instruction may contains corrections and feedback to the answers/responses given by the learner in relation to the tutoring material (Ahuja and Sille, 2013).

ITS are characterized by the fact that they can basically store three types of knowledge, which are domain knowledge, knowledge about learners, and pedagogical knowledge (Salman, 2013).

These types represent the domain model of the tutoring process, which includes all the instructional and teaching methods, such as, tutoring session plan, learning outcome, relevant material (e.g. images, sounds), questions and reference material (Wolfe et al., 2013).

In ITS there are two main issues, which are "what to teach" and "how to teach", the domain model deals with the "what to teach" part whereas the Student and the Teaching model are concerned with the "how to teach" part (Chakraborty et al., 2010).

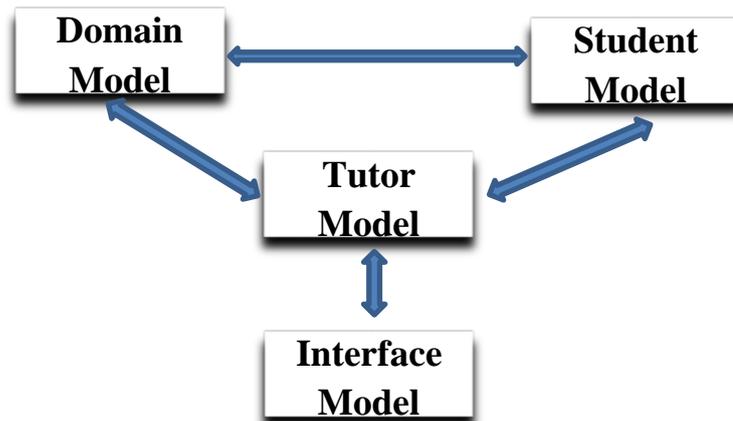


Figure 4.1 ITS Architecture

4.2.2.1. The Domain Model

Constructing the domain model is considered as the first step toward initiating the development of an ITS. The domain model has to be constructed according to the subject matter that needs to be taught to the user/learner (Alvi and Ali, 2010). The domain model stores the content to be taught, the concepts within it (e.g. taught content Maths, related concepts, addition, subtraction) and the relationships between these concepts (Baldwin, 2013).

The domain model can include items such as: the tutoring session plan, learning outcomes, relevant material (e.g. images, sounds), questions and reference material. The domain module will also contain all the elements required to deliver the knowledge to the learner, such as the learning methodologies, strategies or theories (i.e. education theories), taking all the possible steps to solve a problem, evaluate the students' behaviour, and identify errors (Huertas and Juárez-Ramírez, 2013).

In addition, the domain model stores the organised course related content into a number of structured hierarchical topics. Both topics and their associated subtopics for a specific domain are stored in the domain model. Each of the defined topics and subtopics will be presented to the learners according to the sequence defined in the domain model (Yarandi et al., 2013). In order to illustrate this concept, (Yarandi et al., 2012) present a mathematics ITS, by implementing mathematics concepts into a domain model.

The mathematics ITS focusing particularly on teaching fractions to the user/learner. The main topic of mathematics includes subtopics, such as adding, multiplying, and subtracting fractions. These sub topics are further organised through properties, which relate them through pre-requisites subjects that have to be completed before moving through the subtopics. The pre-requisites are defined as properties in the domain model as “IsTaughtAfter”, “IsTaughtBefor”, “HasPrerequisite”, and “IsPrerequisiteFor” (Yarandi et al., 2013).

4.2.2.2. The Learner Model

The student model, or the learner model is considered to be the main module of ITS. The learner model characterises the current knowledge state of the learner. One of the main objectives of the student model is to provide unique assistance tailored to suit the individual learner. The learner model adapts the tutoring in accordance with the abilities and needs of the learners (Mohamed et al., 2012). This is achieved by taking into consideration the learners demonstrated level of knowledge related to the taught content, and the learners behaviour during the tutoring session (Le Corre et al., 2012).

An ITS is able to capture metrics related to certain aspects of the tutoring (e.g. time taken to answer a question) to measure the user’s ability or knowledge, these metrics are then stored in the learner model. By capturing and storing this information in the learner model.

There are many techniques used to represent data in the learner model, such as the skill meters, or the more complex technique such as (Bayesian networks) (Raybourn and Regan, 2011) .

Initially interactive techniques such as asking the user’s level of understanding towards a specific topic before the tutoring session started was used to gauge the users understanding and allow the students to directly edit the learner model before starting the tutoring session.

The intention behind this was adding evidence to the learner model, or negotiation of the learner model to adapt the model before tutoring to suit the individual learners needs (Kay and Kummerfeld, 2012).

This technique, although interactive, was rigid meaning it was not adaptable during the tutoring session. The ITS can provide interactive methods for adding evidence to the student model during the tutoring session by capturing key variables through the user utterances. This would allow the ITS to dynamically adapt the student model based on the knowledge demonstrated by the user throughout the tutoring session and change the tutoring level, style and methodologies accordingly (Morel and Ach, 2011).

The student model can track the learners understanding and the expected behaviour for the student; it can make the right decisions for the learner to adapt the instructional content and guidance. That will lead to intelligent teaching decisions, increasing the ability to understand and deliver the most appropriate teaching methodology and learning style for each learner based on the knowledge stored in the student model (Abdelsalam, 2014).

4.2.2.3. The Tutor Model

The tutor model or pedagogical model, is the model that is concerned about the instructional methods, such as choosing appropriate teaching methods that suit each individual learner (Sani and Aris, 2014). The tutor model will present different kind of information to the learner in accordance to the tutoring topic, such as feedback on the existing topic, answering questions from the learner, or a review of the previous topics (Ricucci, 2008).

The tutor model is responsible for selecting relevant information such as selecting topic and related tutoring questions from the domain model according to the student model information. Subsequently, the tutor model will decide the content of material to be presented to the learner, such as the current topic or subtopic, and the feedback to the learner (Giuffra et al., 2013).

The tutor model will use the knowledge stored in the student model to determine the right way to present the contents to the learner in an appropriate sequence, it can determine and deliver the most appropriate requirements of each learner during the tutoring session (Kumar, 2012).

The objective of the tutor model is to utilise the student model in order to be able to appropriately respond to the students, by selecting the suitable feedback to deliver back to the learner, such as different types of encouragement for the right or wrong answers given by the learner according to the student model (Mining, 2012).

For example, if the student model has determined a student profile with low subject knowledge then more encouragement is given and more in depth explanations are delivered when wrong answers are given.

The tutor model takes an important position in the architecture of an ITS, it has the responsibility of selecting the right teaching method/style to suit each individual learner according to the learner profile data stored in the student model (Sani and Aris, 2014).

4.2.2.4. The User Interface

The Graphical User Interface (GUI) is responsible for communication and interaction with learner and the intelligent tutor, and to control the screen layouts of the system (Ghadirli and Rastgarpour, 2013c).

The main goal for this model is to establish the communication between the ITS and the learner. It is responsible for presenting what is being taught and provide means to the student to explore and answer the questions presented by the system (Tiple, 2013).

Generally the GUI consists of an interface, that contains a textbox to allow the user to enter utterances for the ITS to process. In addition to this ITS GUI's normally have technique within them to deliver hypermedia such as sounds and pictures to the user (Surjono, 2014, Latham et al., 2013).

Advanced ITS provide additional feature within the GUI to enrich the user experience, they incorporate pictures, sounds and media relevant to the tutoring topic to enhance the students learning experience (Muñoz et al., 2013).

4.3. Learning Theories

In simple words, learning may be defined as the permanent change in the behaviour of an individual linked to the experience of tutoring, activity and practice including both observable activity and internal processes such as thinking, attitudes and emotions (Burns, 2002). There has been a lot of research into the way in which groups of people prefer to learn, however, there are a number of differing definitions of the learning theories and styles with educationalists not approving on a particular agreed definition. Over the past century, educational psychologists and researchers suggested many different theories to explain how individuals obtain, organize and arrange skills and knowledge (Riding and Rayner, 2013). There are three basic types of learning theory which are: behaviourists, cognitive information, and cognitive constructivist (Anderman and Corno, 2013). The field of ITS development has seen an increasing interest in the implementation of learning theories, methods and styles into ITS in order to enhance the learning experience for the users (Latham et al., 2012b). Therefore, to implement an effective ITS it is imperative to explore the area of learning related theories and methods and how these theories can be utilised and applied to improve and advance ITS in order to make them more like human tutors. These different approach will be briefly described in the forthcoming sections in connection with ITS.

4.3.1. Behaviourist learning theories

Behaviourist learning is defined by (Bernacki et al., 2013, Aiken et al., 2009), as the gaining of new knowledge, through several components. These components are the mental structure and foundational knowledge of the learner, which leads to acquisition of the knowledge required in solving a particular problem. While (Burns, 1995), considers behaviourist learning as a permanent change in the learner behaviour, including both observable activity and internal process such as thinking attitudes and emotions. Dāboliņš (2012), suggest that behaviourist learning takes place, when there is a observable difference in the learner's behaviour from time period one compared to behaviour in time period two.

This learning theory can be utilised within an ITS through the tutor model. The tutor model in an ITS tries to capture the behaviour related information (for example time taken for the student to respond, the type of response given by the user etc.), from the student's model to provide the type of feedback tailored to suit their individual needs (Rane, 2005). In this sense, it tries to mimic a human tutor intelligently and expertly.

An ITS can divert the learner, when the learners behaviour is moving away from the learner model, by providing the appropriate feedback (Ghadirli and Rastgarpour, 2013d). An ITS can identify and classify the learner type through the behaviour exhibited by the user and select the most suitable topics and how to present them from the domain model. ITS can also evaluate the learning gain of the student which relates to the behaviourist theory of difference in knowledge before and after (period 1 and period 2) the tutoring session. Therefore the behaviourist theory is an appropriate theory which can be applied successfully into an ITS (Kara and Sevim, 2013)

4.3.2. Cognitive-information processing learning theories

The cognitive learning theory focuses on how new knowledge/information is achieved, organised, and recalled. That is, the knowledge/information the humans acquire or loose during the learning process, focusing on the study of the information processing system in the human brain (Groff, 2013).

Atkinson and Shiffrin (1971), proposed a difference between short-term memory and long term-memory in the human brain. This was later followed by the discovery and addition of a third memory store, known as the sensory memory. Sensory memory is defined as the cognitive structure that allows the human to observe new information (Van Merriënboer and Sweller, 2005). The sensory memory is the part of human memory that is recalled on the stimulation of one of the five human senses (i.e. smell, auditory, visual etc.). Figure 4.2 illustrates the theorized process of Cognitive Information Process Theory from input to storage and recall. The figure describes the key component in the cognitive information process, which consists mainly of the sensory memory, short-term memory, working memory, and long-term memory.

The working memory receives information from sensory memory (i.e. visual, and auditory information), then the working memory will process and integrate the information into the long-term memory for storage.

Encoding the information to the long term-memory, can store the information for an indefinite amount of time, and unlimited capacity (Mayer, 2010) . Forgetting certain aspects of newly, gained information can occur regardless of the domain being taught, age or background of the learner. Forgetting is caused by the temporal distribution of the learning, or it could occur either by the information not being attended to (i.e. the information is disregarded) and disappears, or the new information blocks access to the information in a question (Lindsey et al., 2014).

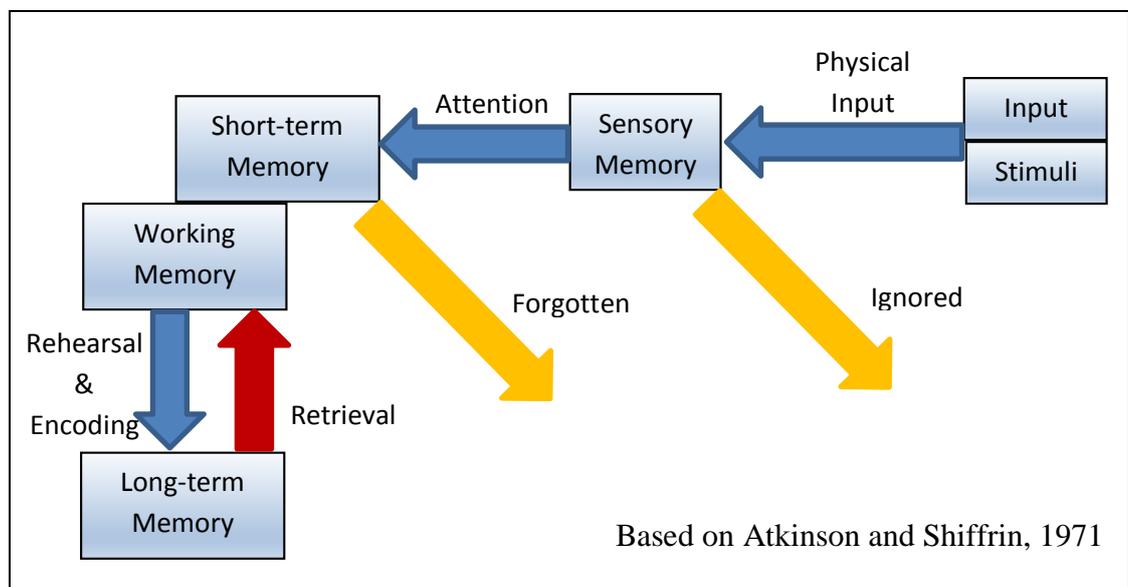


Figure 4.2 Cognitive Information Process Theory

According to the cognitive information process theory there are a number of techniques that can be used to simplify and improve the learning process such as, Gagne's learning theory (Gagné and Gagné, 1985), Piaget's learning theory (Piaget, 1976), and Storytelling learning theory (van Gils, 2005).

The principles of this learning theory are useful in ITS. An ITS can incorporate visual and auditory elements (i.e. pictures and sounds used as learning material) within the tutoring session, which is one of the factors that aid long-term retention of newly acquired knowledge. The next sub-sections will describe each of these learning theories in detail.

4.3.2.1. Gagne Learning theory

Gagne's learning theory specifies that there are different types of learning requiring different types of instructions (Gagne, 1995). Gagne learning theory focuses on intentional or purposeful learning, which is the type of learning that occurs in school or specific training programs.

This type of learning theory is described as a process that follows a sequence of steps starting from gaining the attention of the learner, to the recall of prior learning, to selection into short-term memory, to connecting to previous knowledge, and finally to store that knowledge in the long-term memory (Gagne et al., 2005).

Gagne et al. (2005) , posits nine instructional events, these events should be satisfied to provide the necessary conditions for learning (as shown in Figure 4.3). These conditions are as follows:

1. Gain attention,
 - It is imperative to gain students' attention.
2. Identify objective,
 - Instructors should make students aware of the learning outcome(s).
3. Recall prior learning,
 - It is important to help students recall previously learned information, which might be helpful in learning new material.
4. Present stimulus,
 - New material should be presented.
5. Guide learning,
 - Instructors to provide students with learning guidance. For example, you might suggest an effective way for students to organize the new information.
6. Elicit performance,
 - Students should be given a chance to demonstrate that they have learned the information.

7. Provide feedback,
 - Providing feedback is corrective rather than final. Once feedback has been provided, and mistakes have been addressed.
8. Assess performance,
 - Specifically, whether students have achieved the initial learning outcomes.
9. Enhance retention.
 - The final event of instruction involves retention and transfer. Instructors should strive to reinforce learning and help students apply it to other situations.



Figure 4.3 Gagne's Nine Events of Instruction (Picture source: Google.com)

The Gagne's learning theory has been applied successfully to the design of instructional software in computer assisted instruction environments (Kochakornjarupong, 2010). The Gagne's learning theory has been implemented in a web based learning systems, by implementing the Gagne's nine events which are needed for an effective learning (Hill et al., 2013).

As an example of a software which implement Gagne's learning theory is an e-learning content software for the purpose of teaching to advertise courses offered in college programs (Lee and Lee, 2012). In addition, Gagne's theory is found to be one of the most attractive templates used in the designing of educational computer games (Hodhod, 2010).

Learning theories, like Gagne's is widely used in the field of education, which encourage the use of the modern educational theories in the classroom, this has introduced new teaching methods into the classroom environment such as the use of educational computer games to teach concepts and increase attention and elicit performance (Copp et al., 2013). In addition, Gagne theory has been applied successfully to the design of instruction in a number of domains such as military, flying, leadership, engineering and healthcare domain (Khadjooi et al., 2011).

One of the main advantages of using Gagne's theory is that the applied domain can help teacher for better organization of their thoughts, and to understand what sort of learning to expect from their students in a lesson/tutoring session (Campbell, 2011). Campbell (2011) Also states that the most common disadvantages for applying this theory is that it is not always easy to implement, and to deliver the goals of the lesson to the students.

However, Gagne's theory is a suitable theory for organising and structuring the tutoring of an ITS system (Kochakornjarupong, 2010).

By following the nine conditions of the theory, it allows for systematic and consistent design of tutoring sessions. This concept is important for a software application of an educational nature as it make the learning process more consistent for the user, and it will maximise the learning gain for the learner, while ensuring the tutoring goal is delivered. An ITS system can also adopt more of the nine events as through conversation it can encourage, guide and provide feedback accordingly.

4.3.2.2. Piaget's learning theory

Jean Piaget's theory of learning (Bond, 2012), is focused on children's mistakes during the learning process. Piaget felt that analysing children's mistakes would help provide an insight into children's cognitive development.

According to Piaget, children are active agents involved in determining their own development, and adapting their learning environments.

Through cognitive adaptations, children become better able to understand their world. Piaget addresses two important methods in order for children to adapt their learning (Ackermann, 2001), which are:

- 1- Assimilation is when children learn new objects, and familiar events in their life.
- 2- Accommodation is concerned with the individuals that have to change or modify their plans or the ways of thinking in order to adjust a new situation.

Piaget theory of learning is considered as one of the most accurate theories defining children's cognitive stages (Piaget and Mussen, 1970). It is given greater emphasis when teaching the younger age groups (2 – 11 years old), as it help to determine how much and in what way the learner will understand the topic being taught. Children's learning process has been studied widely in the field of educational psychology (Liew et al., 2010).

According to Piaget's proposed learning theory, children move through four stages of cognitive development from birth and up to the age of 11 years (Kim et al., 2014), as illustrated in Table 4.1 Piaget's Stages of Cognitive Development (Atherton, 2013). Learners at the ages of 7-11, are able to demonstrate by the use of logical and systematic manipulation of symbols associated with the concrete objects. The teachers try to simplify the learning by providing a variety of experiences for the learners to discover and experiment, thus inspiring new understanding. However Piaget theory goes on to outline methods to further enhance the learning of the younger age groups (Orey, 2010) such as:

- Providing visual assistances, such as models and/or time lines.
- Providing hints for the learner where confusion is detected.
- Using familiar examples to simplify learning, such as stories.
- To categorise and group information with increasing complexity, by using hierarchies to simplify new information with previous knowledge.

Stage	Characterised by
Sensori-motor (Birth-2 yrs)	Differentiates self from objects Recognises self as agent of action and begins to act intentionally: e.g. pulls a string to set mobile in motion or shakes a rattle to make a noise Achieves object permanence: realises that things continue to exist even when no longer present to the sense (pace Bishop Berkeley)
Pre-operational (2-7 years)	Learns to use language and to represent objects by images and words Thinking is still egocentric: has difficulty taking the viewpoint of others Classifies objects by a single feature: e.g. groups together all the red blocks regardless of shape or all the square blocks regardless of colour
Concrete operational (7-11 years)	Can think logically about objects and events Achieves conservation of number (age 6), mass (age 7), and weight (age 9) Classifies objects according to several features and can order them in series along a single dimension such as size.
Formal operational (11 years and up)	Can think logically about abstract propositions and test hypotheses systemically Becomes concerned with the hypothetical, the future, and ideological problems

Table 4.1 Piaget's Stages of Cognitive Development (Atherton, 2013)

Nevertheless Piaget's learning theory can be used to classify the cognitive abilities for school aged children, but it is considered not suitable for assessing adult populations (Holden et al., 2012).

Miller (2010), summarise the main weakness of Piaget's theory as a theory of inadequate account of mechanisms of development, and methodological and stylistic barriers.

Piaget theory has been used successfully in ITS in varying domains such as physical properties (weight, volume, etc.), as well as social and spatial domains (Schulmeister, 2012, Swentosky, 2008).

For example teaching fractions and decimals through an ITS to younger age groups (Dowker, 2009). The Piaget theory was implemented in this system successfully. The system gave the students/users the information they requested, based on their knowledge in the taught domain. This was achieved by monitoring the incorrect answers and adjusting the difficulty of the questions asked (Evangelou, 2009).

The concepts of the Piaget theory can be further applied into an ITS through the concepts outlined to further enhance the learning of the younger age groups by providing visual clues and hints when a learner is found to be struggling. This will improve the learning experience for the user and also make the learner more confident to use the system (Carmona and Bueno, 2007).

4.3.2.3. Storytelling learning method

Storytelling is one of the most powerful and simplest methods for learning. The use of stories in education has been found to be most useful in language learning, such as religious subjects, and for encouraging students to share personal experiences (van Gils, 2005). The method of storytelling has also been championed as one of the methods to enhance the learning process by the Piaget theory. Interactive digital storytelling is a valid educational tool to teach multimedia, literacy and narrative skills and has been shown to excite people about learning (Daemi and AliFarnia, 2013).

Storytelling is an effective instructional approach for supporting learning motivations, and improving learning performance, it can develop the learning confidence, and help students to understand complex learning content (Yang and Wu, 2012).

Haigh and Hardy (2011), suggest that implementing digital storytelling can attract the student's interest and enhance their learning achievement.

Digital storytelling is a combined application of both media and software that utilises the art and techniques of digital storytelling. It can help the learner to become more involved in the learning process. (Hung et al., 2012).

This notion is supported by (Petrucco et al., 2013), who state that digital storytelling can undoubtedly become an instrument and technique of teaching that corresponds to classical teaching methods, encouraging interest and the involvement of students. However, stories must also be learner designed, in that they need to be tailored for the specific audience they are delivered to (Skhela, 2010).

In most religious texts, such as the Quran, storytelling is the natural way in which information about the fundamental beliefs of Islam are taught to the younger ages in Islamic schools. Moreover the storytelling learning method is used to guide learners who do not understand the concepts of a particular lesson, storytelling can then be used to structure a lesson in different ways to make it more understandable (Rahimtoroghi et al., 2013).

This section has discussed the different learning theories and method which they are relevance and significance in relation to ITS. Since ITS offer advantages of learning in classroom tutorials, the next section will illustrate the idea of implementing a conversation agent into an ITS and the advantages of the CITS has over a standard ITS.

4.4. Conversational Interfaces to ITS

Conversational ITS (CITS) emulates a human tutor by holding a conversation with the learner in everyday natural language. CITS intelligently analyse solutions and offer problem-solving support rather than simply presenting the answers (Latham et al., 2012b). CITS can act as personal tutors that are available at any time and place, and which provide instant answers to questions, feedback, and support (Rodrigo et al., 2012).

Conversational interfaces to an ITS can add more naturalization to the tutoring, allowing students to experience cooperative problem solving similar to with a human tutors. However the Arabic conversational interface to ITS is a new area of research. To our knowledge, no academic research exists on the conversational intelligent system based on the Arabic language.

4.4.1. Review of Conversational ITS

Using a CA interface to ITS has shown some success in learning, in a number of CITS, such as AutoTutor (Graesser et al., 2012), Oscar (Latham et al., 2010b), and CycleTalk (Kumar and Rosé, 2010). A key feature of these three CITS systems is that they have all been developed for the English Language. Each of these CITS system will now be critically reviewed.

4.4.1.1. AutoTutor Conversational ITS

AutoTutor is a CITS that assists the student in actively constructing knowledge, about computer literacy and Newtonian physics through discussion (Cheng et al., 2013). AutoTutor provides the knowledge to the learners in the form of media technology, which includes images, audios, videos and other interactive presentations developed by the Media Semantics Character Builder program (Cheng et al., 2013). AutoTutor works by having a conversation with the learner, with a talking head that acts as a personal tutor. However the main goal of the AutoTutor CITS is to encourage students to show lengthier answers to questions that exhibit deep reasoning such as (answers to why, how, what-if questions), while directing the students towards constructing a solution (Graesser and McNamara, 2010).

Sentence similarity measure, is the main approach used by AutoTutor to measure the similarity between the learner's contributions and the expert answer. The expert answer is supposed to be correct all the time, and the learner contribution is considered to be correct if it is semantically similar to the expert answer (Rus et al., 2013). A tutoring session consist of a set of questions and answers that cover the curriculum, and for each of these questions the students have to apply their knowledge to answer. The curriculum which consists of both the domain and tutoring model, considered as the critical component in the tutoring session. It consist of the expected answer, the prompt questions, and hints (D'mello and Graesser, 2012). AutoTutor is not able to adapt the tutoring to suit different levels of knowledge during a tutoring session, which effectively means each student is provided with the same learning experience regardless of the ability or the level of knowledge related to the tutoring material. The success of conversational tutoring systems is evident from reviewing AutoTutor's history (Benjamin et al., 2014). Auto tutor shows conversation based tutoring systems can help students in a wide array of domains and subject matter. Furthermore, the success of conversational agents in different applications and context is a validation of the core concepts of AutoTutor's. Conversational agents offer a universal interface for tutoring that can incorporate a variety of pedagogical strategies (Nye et al., 2014).

4.4.1.2. Oscar Conversational ITS

Oscar is conversational intelligent tutoring system which employs a conversational agent to lead the tutoring (Latham et al., 2012a). Oscar was initially developed to provide a Structured Query Language (SQL) revision tutorial for undergraduate students. One of the main features of the Oscar CITS is that it adapts to the individual learning styles of the learners to improve the effectiveness of the tutoring and to deliver personalised learning.

Learning styles describe the way in which a group of people prefers to learn, for example by active experimentation or by observation (Latham, 2011). Oscar CITS can direct the tutoring conversation, and adapting to an individual in learning style to suit the learner suitability methods of learning. The standout drawback of the Oscar CITS adaptation method is the time and expertise required to model the tutorial and scripting language for the knowledge engineering of the learning styles model (Latham et al., 2014). Although the teaching material categories developed by expert lecturers can be applied to other learning styles models, the implantation of this will be a laborious task.

4.4.1.3. CycleTalk Conversational ITS

CycleTalk tutor (Kumar and Rose, 2011), is a conversational intelligent tutoring system that helps sophomore-engineering students learn the principles of thermodynamic cycles in the context of a power plant design. CycleTalk is implemented on a number of social interaction strategies, which are divided into two main parts. They are the positive and negative socio-emotions, such as do introductions, be protective, give re-assurance, and complements, etc. (Kumar and Rosé, 2010). The second part focuses on behavioural strategies such as eye-gaze and facial expressions, in order to establish the connectivity of the user to the agent. In the CycleTalk tutor agent, undergraduate engineering students work in pairs to learn principles of thermodynamics cycles. The collaboration environment consists of text-based chat. As students work on a design challenge, the CycleTalk tutor offers instructional support via tutoring scripts (Harsley, 2014).

Individual students working with a conversational agent learned more compared to the students working in groups. A disadvantage of the CycleTalk system was that the only focused on the emotional and social aspects of the user's interaction. The system was not able to adapt the tutoring content to the suit the individual learner's level of knowledge, the tutoring content was delivered in a single style to all students (Harsley, 2014).

4.4.2. Challenges to Conversational ITS

CITS are currently not in wide popular use, despite offering many advantages to computerised learning systems. There are a number of challenges to Conversational ITS, which can be summarized as follows:

1. Currently there are few CITS which are based on the English language, to the researcher knowledge there are no CITS based on the Arabic language.
2. CITS try to help learners construct explanations by interacting with them in natural language by interacting with a pedagogical agent, who may provide information, encouragement, or collaborate with the learner (Veletsianos and Miller, 2008). A corresponding challenge is to design a pedagogical agent that can provide complete and specific information that is suitable to student's experiences and abilities.
3. The CITS task is to try to improve the users knowledge by encouraging students to articulate a lengthier answer to a specific questions, which shows a deeper reasoning (such as why, how, and what-if questions). This conversational method is more advantageous to the traditional ITS methods such as multiple choice, or true-false questions to elicit answers from users.
4. The CITS conversational method focuses on encouraging the user to give more information, which requires a much deeper understanding of the user utterance as opposed to simply asking multiple-choice questions to direct the conversation.

However there are many questions that could be asked to any Conversational ITS but the main two questions that might be asked are:

1. Does the CITS actual teach the learner anything and how can this be assessed?
2. If the same material was to be delivered by a human, how much of a difference would there be in the students learning?

4.4.3. Evaluation of a Conversational interface to ITS

As the field of CITS is relatively new, there are not many methodologies developed to evaluate the performance of CITS.

One example found in the literature is AutoTutor, which consider the best known, and the most developed CITS. The main goal behind the evaluation of AutoTutor was whether the CITS system was helping the students to learn. The evaluation of AutoTutor focused on measuring Learning Gain of the students. The learning gains of AutoTutor have been evaluated on the number of participants measuring their understanding of the topic at the end of the AutoTutor tutorial.

The learning gain will measured by comparing the students score test before the tutoring conversation begin and after the tutoring ends (D'mello and Graesser, 2012).

The subjective evaluation of CITS is generally conducted by administrating a questionnaire to the learners/users of the CITS, in order to discover their subjective assessment of their interaction and experience with the conversational ITS.

A questionnaire was distributed to the students, to capture aspects of the CITS abilities, e.g. whether the system understood user utterances, could give correct responses, and the naturalness of the CA.

4.5. Conclusion

Learning is a hard and very difficult process, and all human experts learn as they perform their own skills and expertise. Expert intelligent systems, including ITS, with fixed knowledge bases are inherently limited. ITS can give instant feedback and individual assistance in constructing solutions to problems, but the primary goal of the ITS field is to mimic human tutors by adapting instruction to an individual student's performance.

However, ITS are not widely used, and there are a number of challenges for ITS, such as the effective assessment and representation of the student's knowledge. In addition to that, the specific need in the problem domain based on uncertainty information.

Most ITS are student directed, the student enter queries into the system to gain responses to their queries, therefore the tutoring is limited to the questions asked by the user. A CITS can provide a solution to this problem by supporting the construction of knowledge through discussion with the system, and a system lead tutoring session.

The consideration of learning theories when implementing an ITS has shown good results in recent ITS. The most recent Conversational ITS, can adapt to mood and emotion of the learner.

Learning theories have been used within both ITS and CITS Successfully, however no CITS developed for both MSA and CAL. The next chapter brings together the background work on the CA, ITS, and the combination of both the modern and classical Arabic language. While in the chapter 7 the learning theories will be implemented in the conversational intelligent tutoring system.

CHAPTER 5 A METHODOLOGY AND ARCHITECTURE FOR DEVELOPING AN ARABIC CITS

5.1. Introduction

Computer Assisted Learning can assist the students by offering a flexible learning at any time or place (see chapter 4 section 4.4). Existing ITS have shown that presenting the tutoring content using a variety of media can help to enhance the students learning process (chapter 4 section 4.2.1).

As described in Chapter 4, an Intelligent Tutoring Systems (ITS) is a computer software designed to mimic a human tutor's behaviour and guidance. It can assist students studying by presenting a variety of topics, allowing the students to ask questions, and offering customized instruction and feedback. It was established that no Arabic CITS was currently existence. One of the main reasons was the lack of Arabic conversational agents and the associated language technologies.

This chapter outlined a methodology for extracting a user's level of Islamic knowledge, which can then be used to direct the users through an appropriate tutoring session. Extracting such knowledge from the user is required by the conversational intelligent tutoring system (CITS), so that it can mimic a human tutor by leading the user of the CITS through a pre-determined tutoring topic that is suited to that particular user's knowledge level.

This chapter introduces a novel CITS called Abdullah, which can deliver topics related to Islamic education by engaging with the user in both modern and classical Arabic language.

The Abdullah CITS consists of a number of components including the development of an Arabic intelligent tutoring system architecture, Arabic conversational agent and new scripting language based on both pattern matching and short text semantic matching. To the author's knowledge it is the first Arabic CITS of its kind and has the ability to converse in both modern and classical Arabic language. Abdullah CITS is able to determine the user/learners level of Islamic knowledge by analysing the user input and based on this is able to adjust the teaching method to suit that user's level of knowledge. In this chapter, section 5.2 will give an overview of the Abdullah CITS methodology. While section 5.3 will present the architecture of the Abdullah CITS.

In summary, the main features of the Abdullah CITS are:

- Abdullah CITS can mimic a human tutor by leading the user through determined topics for Islamic education.
- Abdullah CITS is able to deliver Islamic educational topics by engaging in both MSA and CAL.
- Abdullah CITS implements a new non-question sentence analyser, to classify user utterances to improve the Abdullah CITS robustness (Section 5.3.1.4).
- Abdullah CITS is able to utilise several different mediums to enhance the learning experience such as pictures, and sounds.
- Abdullah CITS uses a novel short text similarity measure that is able to extract knowledge from the Islamic knowledge base, which uses CAL (Quran and Hadith), based on the user input which is in MSA, to deliver Islamic education.

The aim of the CITS is to mimic a human Arabic tutor who is able to link the modern standard Arabic language to the classical Arabic language and teach students about topics related to Islam. This is achieved in Abdullah CITS by engaging the users in dialogue using modern standard Arabic language (MSA) and allowing conversation and discussion with verses in classical Arabic language (CAL), utilizing supportive evidence from the Quran and Hadith.

Abdullah CITS implements novel algorithms and architecture components in order for the system to recognise both versions of the Arabic language and deliver a coherent and engaging tutoring session.

5.2. Methodology for creating an Arabic CITS Architecture

This section describes the design and development of an architecture for a Conversational Intelligent Tutoring System CITS called Abdullah. The Abdullah CITS was constructed based on two phases. The first phase of the methodology relates to the design and implementation of an Arabic CA, and the second phase will introduce the intelligent tutoring system interface to a conversational agent. Both phases come together to form the final CITS. Each phase will now be described.

5.2.1. Phase 1: Creation of an Arabic CA Architecture

The Arabic CA was designed based upon a number of features specifically to deal with the challenges of the Arabic language in terms of its morphological and grammatical nature. The research focused on the following areas:

- A. Research and examination of the complexity of the Arabic language to the CA (section 3.2).
- B. Research and examination the CITS components (section 4.45.3).

The Arabic CA was developed based on a number of novel features that were designed to deal with the complex language features of the Arabic language. These features can be summarised as follows:

- Capturing variables from user utterance feature (section 5.3.2.2.2)
- Abdullah CITS Non-question Sentence Analyser (section 5.3.1.4)
- Capturing the emotional values from utterance (section 5.3.1.4)
- Managing response generation feature (section 5.3.2.2.3)
- Macros feature in CA (section 5.3.2.2.4)
- Rules with dynamic information in CA (section 5.3.2.2.5)
- Rule condition feature (section 5.3.2.2.1)

The Arabic CA allows the user to converse in both MSA, CAL and overcome the language unique challenges of the Arabic (ambiguity, diacritics etc.).

The main components that make up the architecture of the Arabic CA are illustrated in (Figure 5.1), and can be summarised as follows:

1. The domain, which includes both the Arabic CA scripts, and the Islamic DB.
2. The Controller, to manage the conversation between the user and the Arabic CA.
3. Conversation Agent manager, to manage the flow of the conversation.
4. Pattern Matching (PM), to handle user's conversations (when the user converse in Modern standard Arabic language).

5. Short text similarity (STS), is utilised to search through the Islamic database (when the user converses in classical Arabic language).
6. Arabic grammar DB, which contains the classification of the Arabic, sentences (i.e. Questions and Statements sentences).
7. Facts DB, which contains a set of facts describing some particular concrete situation about the three fundamental principles of Islam.
8. The Graphical user interface, which allows natural language interaction between the user and the Arabic CA.

However in phase one (section 5.2.1), the components of the Arabic CA and their functions are described in detail, as well as in this phase the creation of the new Arabic scripting language is taken place.

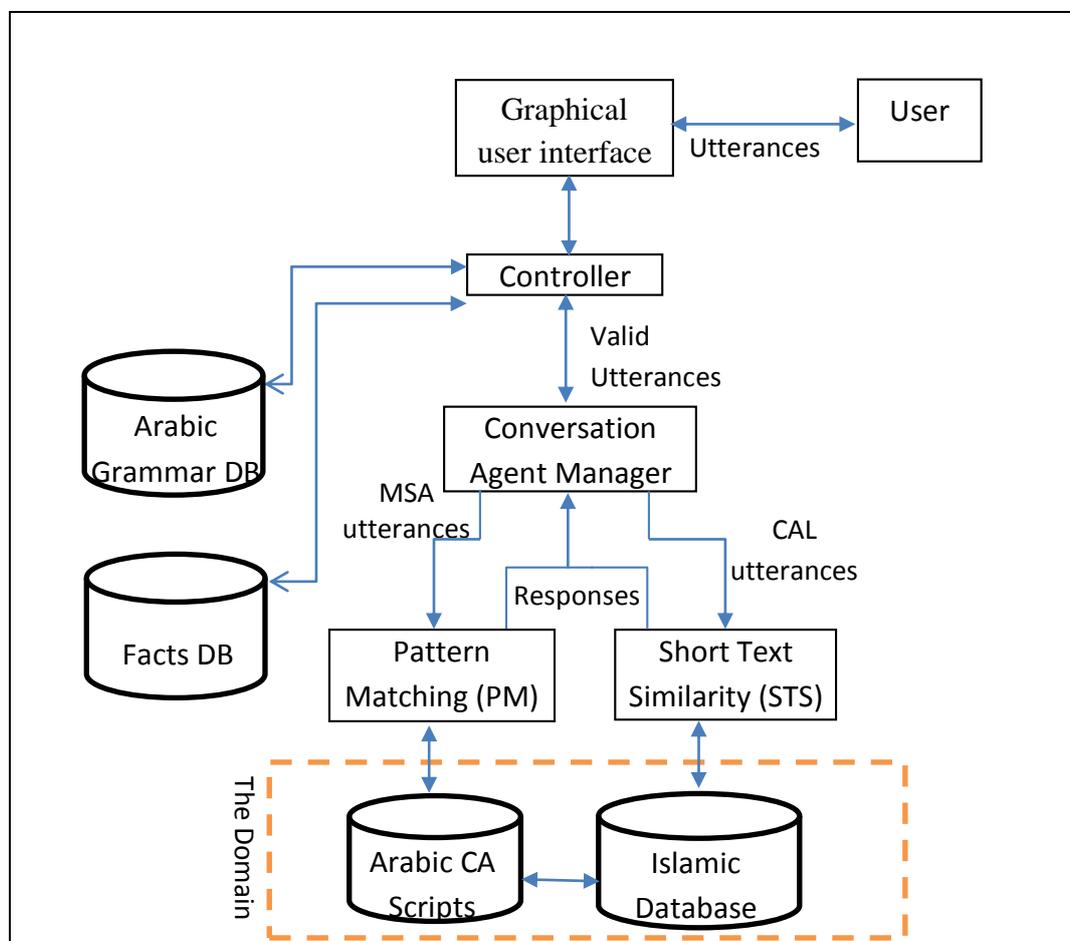


Figure 5.1 Arabic CA Architecture

5.2.2. Phase 2: Creation of ITS architecture to Arabic CA

Phase 2 will create the ITS (Figure 5.2) that can adapt to suit different learners with different knowledge and behaviour, as discussed in (chapter 4 section 4.2.2). The ITS architecture consists of four main components, which are:

1. ITS manager, which is the main component in the ITS which interacts with the user through the GUI, and ensures that the user is following the topics and subtopics stored in the tutorial knowledge base.
2. Tutorial Knowledge Base, which contains a number of structured topics and sub-topics to present the tutoring contents to the user.
3. Temporal Memory Database, which record the student's responses during the tutoring session for further analysis.
4. Graphical user interface, considered as the interaction point between the user and the ITS components.

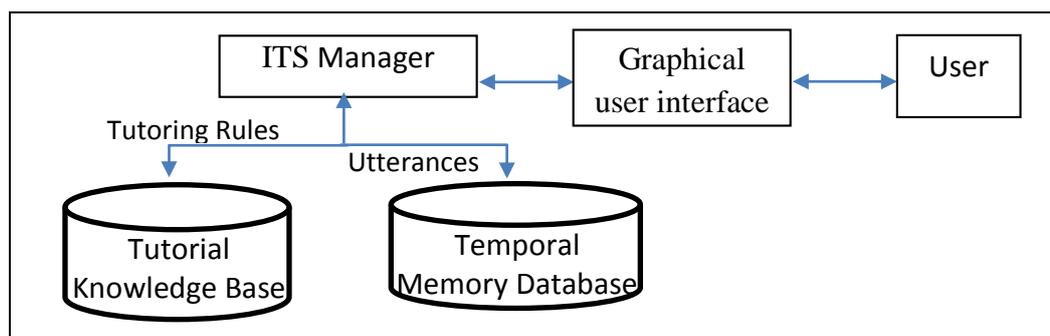


Figure 5.2 ITS Architecture

The Arabic Conversational Tutoring System (CITS) was designed by combining both the Arabic CA (illustrated in Figure 5.1), and the ITS (Figure 5.2). The architecture and description of the Arabic CITS can be found in section 5.3.

5.2.3. Methodology for the Development of a Modern and Traditional Arabic Scripting language

A new Arabic scripting language was researched and implemented in order to overcome the shortcoming in existing scripting languages. As discussed in chapter 3 (section 3.3.3), there are a very limited amount of Arabic CA's in existence and no Arabic CITS (section 4.4.3).

Therefore this research required the development of a novel scripting language that would enable the Arabic CA to incorporate the features of an ITS, in order to deliver tutoring sessions in the Arabic language. The developed Arabic scripting language provides the Abdullah's CITS domain with the required information to enable the Abdullah CITS to interact with the user using modern standard Arabic language, the developed scripting language will discussed in details in section (5.3.2).

The methodology for the development of the Arabic scripting language followed the following steps:

- A. Research and examination of the existing scripting methodology for both Arabic and English language.
- B. Design of a method for mapping subtopics from knowledge engineering phase to contexts.
- C. Development of the run SQL layer, which allows the Arabic CITS to retrieve an appropriate verse from the Quran to help answering user query.
- D. Knowledge engineering the specific tutoring domain.
- E. Implementing the tutoring material, illustrated in (chapter 7).

5.3. Abdullah CITS ARCHITECTURE

Once the Arabic CA architecture and ITS architecture had been designed (section 5.2.1, and section 5.2.2), it is possible to combine them into a CITS architecture.

The developed Arabic CITS will require a number of components, containing an Arabic CA, short text similarity, pattern matching, and tutorial knowledge base. The proposed architecture for Abdullah CITS consists of three components as shown in Figure 5.3.

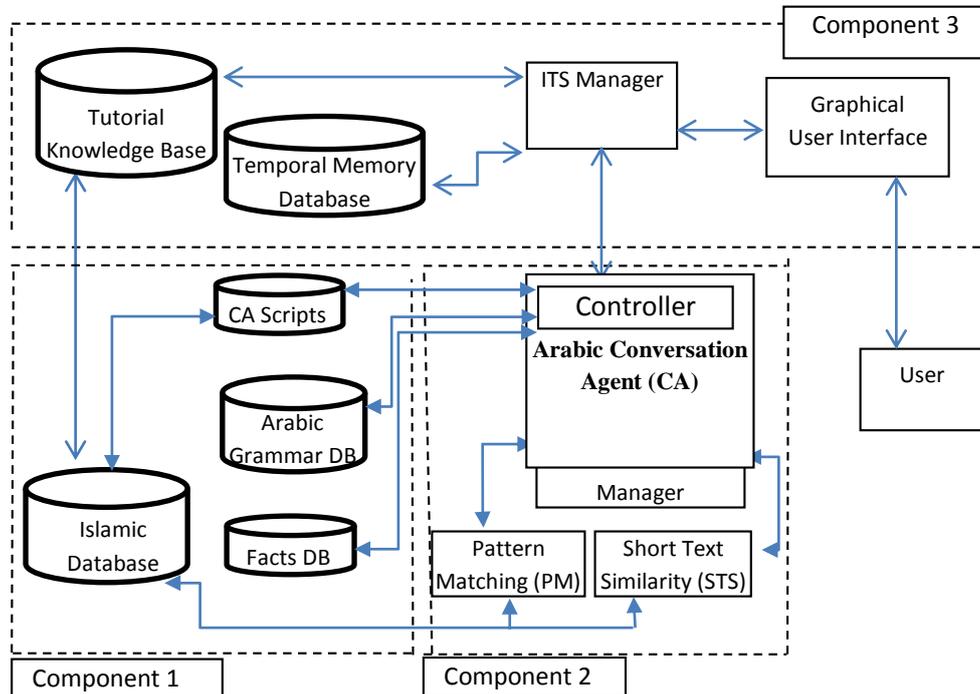


Figure 5.3 Abdullah CITS ARCHITECTURE

The Abdullah CITS architecture was designed based on a number of components, which are component 1 (consisting of Islamic DB, Arabic grammar DB, Facts DB, and CA scripts), component 2 (the Arabic CA), and component 3 (the ITS). These components are the essential parts of Abdullah CITS architecture, and will be described in detail in the following sections.

5.3.1. Designing and Building Abdullah CITS Knowledge Base

Abdullah CITS consists of five main knowledge databases that are the Islamic Database (IDB), the Arabic Grammar Database (AGDB), CA Scripts (CAS), Facts DB, and Tutorial Knowledge Base (TKB).

These databases work together, and are considered as being the brain of Abdullah CITS. The design process of Abdullah CITS knowledge base, are based on the knowledge engineering Arabic CA domain, which will be explained in the following section.

5.3.1.1. Arabic CITS Knowledge Engineering

Jee et al. (2014) , defined knowledge engineering as the process that involves capturing, representation, encoding, and testing of expert knowledge. In this section, the knowledge engineering process of Abdullah CITS will discussed.

5.3.1.2. Knowledge Engineering the Arabic CA domain

Knowledge Engineering was used within the Abdullah CITS, to script the Arabic CA domain. The representation of a knowledge base is required in order to lead the user through a tutorial in a goal orientated CA (Mohammed Abbas Kadhim, 2014). The domain used to script the Arabic CA is concerned with teaching the three fundamental principles that every Muslim must learn which is to know your God (Allah), his messenger (Prophet Muhammad), and the religion of Islam, with the supportive evidences (Quran and Hadith). The knowledge engineering of a CA involves a number of processes, which are the knowledge extraction (section 5.3.1.2.1), and knowledge presentation (section 5.3.1.2.3).

5.3.1.2.1. Knowledge Extraction

One of the main processes of knowledge engineering is the knowledge extraction, which is defined as the process of creation of the knowledge from structured relational database (i.e. Islamic DB) (Auer and Lehmann, 2010). The knowledge base of Abdullah CITS consists of two main parts. The first part of the knowledge base is derived from the learning material such as the Quran, Hadith, and other Islamic knowledge such as the facts DB that is related to the religion of Islam, and conversation related content such as Arabic grammar and the Arabic scripts. The second part of the knowledge base is related to the ITS, known as the tutorial knowledge base (TKB), which is illustrated in section (5.3.3.1). This part consist of structured tutorials, which utilise the knowledge stored in the Islamic DB in order to teach the topics of the selected domain. The tutorials stored in the TKB outline the conversation path of each context of the tutorial.

The contexts represent a path/branch that each tutorial will follow. Each path/branch has sub-topics that are related to the main topic and learning outcome/goal of each branch as illustrated in (Figure 5.4).

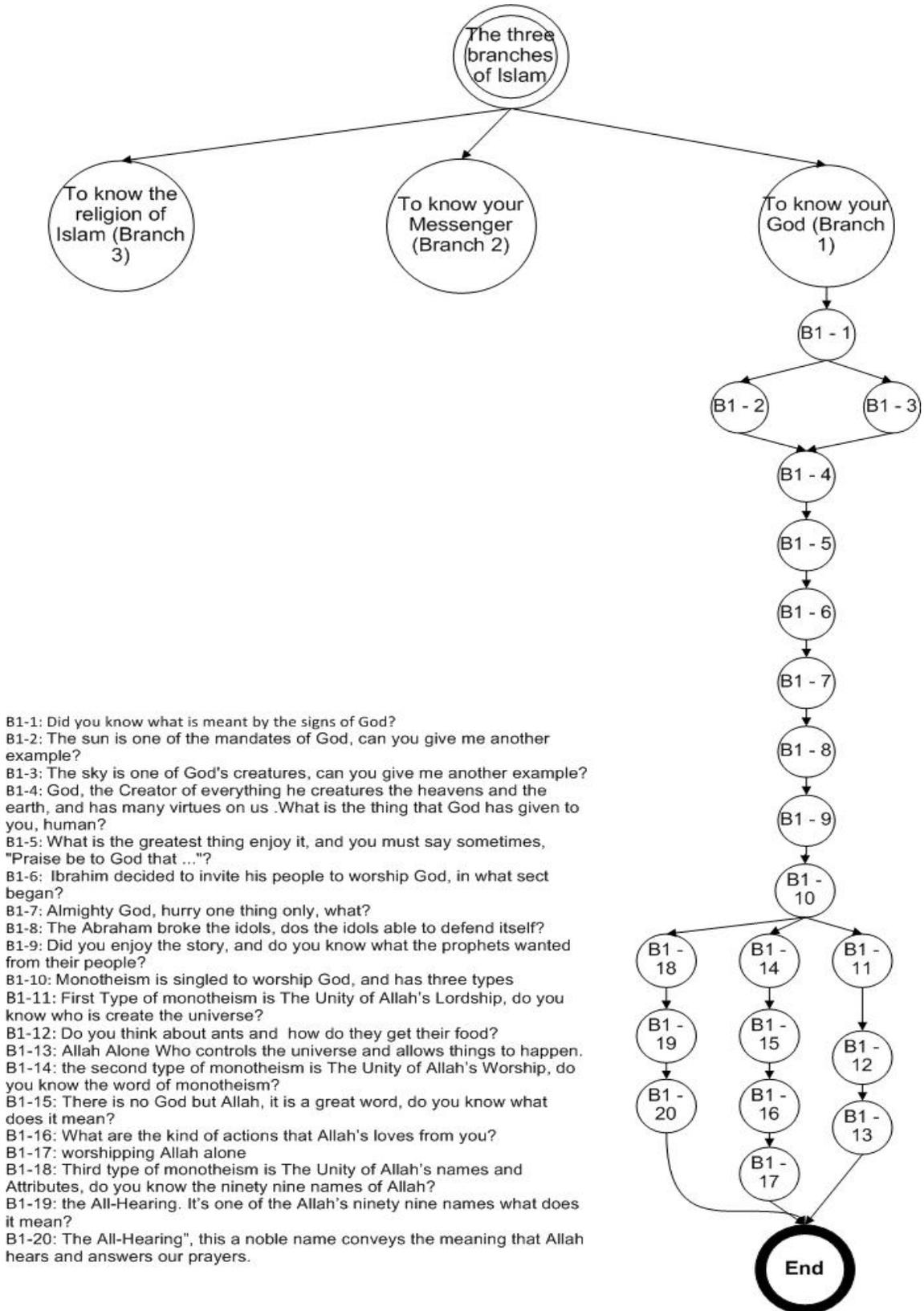


Figure 5.4 Tree Data Structure for tutorial knowledge base

The three fundamental principles were structured/devised according to the information captured during the interviews with the Islamic schoolteachers (see section 5.3.1.2.2 for interview findings). Each branch is structured similar to the way the human tutors were teaching the children in their classes, with learning outcomes and related questions for each branch/context that was to be taught to the students. These two parts of the knowledge base (CA KB and TKB), work together to deliver the tutorial sessions to the students through discussion.

5.3.1.2.2. Tutors interview

Interviews with actual Islamic school tutors were conducted to, in order to design and deliver an Arabic CITS closely mimics the human counterpart. The interviews consisted of semi-structured questions that were asked to the tutors. The answers provided by the tutors formed the basis of the tutorial design implemented in the system, as well as provided insight into what elements should be included into the knowledge base. Furthermore, the interviews with the tutors provided insights into the teaching styles and methods that were utilized by the tutors to teach the Islamic subjects. The interviews were all conducted in the 'Almanar Supplementary School' in Manchester, and lasted around 40-60 minutes with each interviewee. The interviews were conducted with the school head teacher (Alobaidi Omar and Rabah, 2012), and with the Islamic year 5 and 6 tutors from Manchester as well as a year 7 tutor from Jordan (Alobaidi Omar and Aldouri, 2011, Alobaidi Omar and Aljush, 2013, Alobaidi Omar and Alhessa, 2013). The interviews started by asking a number of questions pre-prepared by the author, and finally a short open discussion about teaching Islamic topics and the school strategy with regards to this subject. The author's questions can be summarised as follow:

1. What are the different kinds of curriculum used for teaching Islamic topic in year 5 and 6?
2. How do you teach in the classroom, or what are the teaching strategies followed in this school?
3. How the class is managed?
4. How long is a typical tutoring session?
5. How do you deal with students with different behaviours?

6. What kind of questions and activities are prepared to suit the diverse needs of students according to their abilities, gender, and special needs?
7. What sort of supporting materials/sources are used?
8. What type of examples do you use during the tutoring?

The findings from these interview provided invaluable insights into real world teaching. The interviewees shared their individual experiences and knowledge that will be taken into consideration and have influence on the design and implementation phase of Abdullah CITS. It can be concluded from the interviews that the teaching strategies that are implemented in the Almanar School are based on a number of procedures, which include:

1. Teachers should know the subject they teach (i.e. Islamic Education book year 5, and Islamic Education book year 6 (Jordan, 2011)), and how to teach those subjects to diverse learners.
2. Commitment to achieve specific goals for each lesson, and make the subject matter as easy as possible for the student to understand.
3. Summarise the goals of the lesson on the blackboard, define it to the students, and then start the lesson.
4. The tutors are encouraged to use multiple methods/styles of learning in the classroom to suit the tutoring content/subject. For example, dialogue and discussion, storytelling, analysis concepts, role-playing, group work.
5. Using appropriate images/media to suit the subject of the lesson or unit in order to make the content easier to digest by students.
6. The student should know the title of the unit before starting the lesson, the students should recognize the meaning not necessarily to memorise it.
7. Linking content to the real world calendar events such as fasting in the month of Ramadan where possible.
8. Try to connect to modern events and then extract the conclusion of the lessons.
9. Use Quran verses by linking them to the rest of the principles of Islam.
10. Link and illustrate tutorial content to the sequence and present the life and legacy of the prophet Muhammad.
11. Differentiate between the Hadith and the Quran, with a description of the importance of the Quran.
12. Explain the close link between worship and monotheism.

13. Create the tools needed to implement the lesson materials (such as smart board content/slides etc.).
14. Enrich the necessary information, related directly to the teacher and students, which aims to raise student motivation and help them to learn and to enrich the acquired knowledge.
15. Tutors must consider the length of time to achieve the expected learning outcomes.
16. Plan and acquire the learning resource required (Quran, Hadith, etc.), which students can refer to in order to increase the students' knowledge and experiences.
17. An adjustment in teaching level (i.e. encouragement, reward) when the teacher discovers evidence of a superior or weaker students.
18. With slow learning students use several methods of reinforcement (i.e. illustrated pictures, sounds, videos, etc.).
19. With slow learning students, use diversification of the learning methods (i.e. hints, rephrase questions, etc.). Provide additional help wherever possible.

5.3.1.2.3. Knowledge Presentation

The tutorials that are presented in the knowledge base were also devised through the interviews. The intention behind the meetings was to gain first hand insight from experienced Islamic tutors who teach children on a daily basis. The tutors were interviewed informally about their experience of teaching children the Quran and Islamic education. The interviewees gave valuable information concerning their teaching methodologies and styles to keep the children interested and engaged in a tough topic like the Quran, which can even be challenging adults to learn and understand. The tutors shared their recommendations as to the best methods for keeping the teaching interesting and fun for the children, for example using pictures, sounds and colours throughout the tutoring sessions. As well as insight into their teaching methods, the tutors also shared their experience of the best sources and material they used for teaching the Quran and Islamic studies to the children, based on the recommendations from the interviews with the tutors and through additional research.

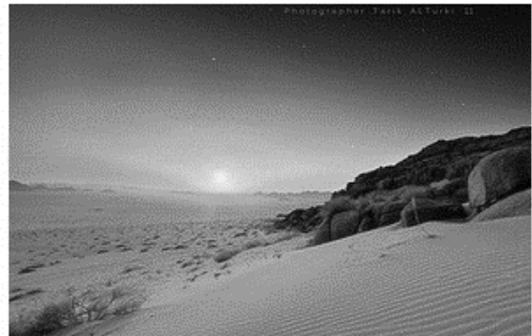
The material and knowledge sources that are utilised and presented within Abdullah CITS were obtained and developed. Figure 5.5, shows how the knowledge has been presented to the users in Abdullah CITS. The three pictures and verses presented in the below figure are linked to the first branch (to know your God), which illustrate the method of presenting the knowledge to the user. As an example, the first pictures in Figure 5.5 present the first creation of God's, which is the Sun. This verse with the associated picture, will link the topics of the tutoring as illustrated in (Question 2 in Figure 5.4).

Quran verses (extracted from Quran Database)

Pictures (extracted from CA scripts Database)

وَمِنْ آيَاتِهِ اللَّيْلُ وَالنَّهَارُ وَالشَّمْسُ وَالْقَمَرُ ۚ لَا تَسْجُدُوا لِلشَّمْسِ وَلَا لِلْقَمَرِ وَاسْجُدُوا لِلَّهِ الَّذِي خَلَقَهُنَّ إِن كُنتُمْ إِيَّاهُ تَعْبُدُونَ (٣٧)

And of His signs are the night and day and the sun and moon. Do not prostrate to the sun or to the moon, but prostrate to Allah, who created them, if it should be Him that you worship.



إِنَّ رَبَّكُمُ اللَّهُ الَّذِي خَلَقَ السَّمَاوَاتِ وَالْأَرْضَ فِي سِتَّةِ أَيَّامٍ ثُمَّ اسْتَوَىٰ عَلَى الْعَرْشِ يُغْشِي اللَّيْلَ النَّهَارَ يَطْلُبُهُ حَبِيبًا وَالشَّمْسَ وَالْقَمَرَ وَالنُّجُومَ مُسَخَّرَاتٍ بِأَمْرِهِ ۗ أَلَا لَهُ الْخَلْقُ وَالْأَمْرُ ۗ تَبَارَكَ اللَّهُ رَبُّ الْعَالَمِينَ (٥٤)

Indeed, your Lord is Allah, who created the heavens and earth in six days and then established Himself above the Throne. He covers the night with the day, [another night] chasing it rapidly; and [He created] the sun, the moon, and the stars, subjected by His command. Unquestionably, His is the creation and the command; blessed is Allah, Lord of the worlds. (54)



وَإِن تَعُدُّوا نِعْمَةَ اللَّهِ لَا تُحْصُوهَا ۗ إِنَّ اللَّهَ لَغَفُورٌ رَّحِيمٌ (١٨)

And if you should count the favors of Allah, you could not enumerate them. Indeed, Allah is Forgiving and Merciful. (18)



Figure 5.5 Knowledge Representation

There are three tutorial have been constructed based on the year 5, and year 6 books of Islamic education (Almaree, 2012) as well as the supportive resources such as (Quran and Hadith).

Each tutorial is grouped into a number of topics and subtopics (Knowledge Engineering the Arabic CA domain); each of these subtopics contains one or more questions (maximum of 3 questions for each subtopics). These subtopics are linked together, and the user can move from one subtopic to another by answering the question related to that subtopic (Figure 5.4).

5.3.1.2.4. Designing the Tutoring Conversation

The intention behind the design of the tutoring conversation is making the conversation as close as possible to the human tutors, by mimicking a similar tutorial method and style that the tutors exhibited during the observations and the insights they shared during the interviews.

Subsequent to deciding the subject domain (the three fundamental principles of Islam), the tutorial scenario/atmosphere/environment from the Islamic human tutors has to be captured and transferred into Abdullah CITS. Therefore to mimic the human tutors styles and teaching methods the supportive Islamic teaching resources such as (Quran, and Hadith), as well as images, movies etc. should also be implemented in the tutorial conversation.

This is done by mapping tutorial questions and answers stored in the TKB to the Islamic teaching resources (Quran, and Hadith) in the conversation agent knowledge base. Another advantage gained through the implementation of the Islamic teaching resources into the knowledge base, is that Abdullah CITS can answer student questions related to the topic that are not necessarily a part of the tutoring session but are related to the topic. The answers that Abdullah CITS gave are extracted from the teaching resources stored in the knowledge base such as (Quran, and Hadith). This information gives Abdullah CITS a vast amount of knowledge on a wide array of Islamic topics, thus making Abdullah CITS more intelligent and capable to answer related questions to the tutoring topic and Islam in general.

5.3.1.3. Islamic Database (IDB)

The Islamic Database (IDB) is the most important part in the Abdullah CITS brain, as it is the source of the tutoring material during the session. The Islamic Database has been derived from two main sources: the Quran and the Hadith (the statements of prophet Muhammad) (Burton, 1994).

The Quran is originally written in classical Arabic language, and is organized into 114 chapters of various lengths with specific number of verses in each chapter. In total, the Qur'anic text consists of 6,236 verses in 114 chapters. The Quran in the IDB was organized according to the ALmedina Holy Quran (al-Juhani, 2002). ALmedina holy Quran it is an extremely clear Arabic text distributed free of charge during the annual Hajj pilgrimage, the text was imported from the Tanzil Project (Rippin, 2013).

The Tanzil Quran (Tanzil Project) text is carefully derived from ALmedina, which is currently the most authentic copy of the holy Quran. The Hadith is organized according to Sahih Al-Bukhari (Al-Bukhari, 1987). Al-Bukhari groups the Hadith into a number of chapters, each one covering the almost important aspects of Muslim life (so there is for example a chapter about prayers, charity, and so on) (Khan, 1997). The Hadith was imported into the knowledge base from the Al-Bukhari textbook which contains over 7500 hadith with repetitions in 97 chapters (Ibnjamaa and Hussen, 1992). Table 5.1 shows an example of the contents of the Islamic Database used within Abdullah CITS.

Volume Number	Book Number	Hadith Number	Hadith Text (Arabic)	Hadith Text (English translated)
Volume 1	Book 1: Revelation	1	<p>عن أمير المؤمنين أبي حفص عمر بن الخطاب رضي الله عنه ، قال : سمعت رسول الله صلى الله عليه وسلم يقول إنما الأعمال بالنيات ، وإنما لكل امرئ ما نوى ، فمن كانت هجرته إلى الله ورسوله ، فهِجْرته إلى الله ورسوله ، ومن كانت هجرته لدنيا يصيبها ، أو امرأة ينكحها ، فهِجْرته إلى ما هاجر إليه رواه البخاري ومسلم في صحيحهما</p>	<p>Narrated 'Umar bin Al-Khattab: I heard Allah's Apostle saying, "The reward of deeds depends upon the intentions and every person will get the reward according to what he has intended. So whoever emigrated for worldly benefits or for a woman to marry, his emigration was for what he emigrated for.</p>

Table 5.1 Hadith of the Prophet Muhammad

5.3.1.4. Arabic Grammar Database

The Arabic Grammar Database (AGDB) is an essential part of Abdullah CITS as it contains the classification of the Arabic sentences (i.e. Questions and Statements sentences). The Abdullah CITS is required to classify the user utterances in order to formulate suitable/appropriate response based on user's utterances types. In Arabic grammar, a question is defined as a sentence that is beginning with one of the interrogative words such as (who, what, when, where, how, why, etc.), while statements are defined as a group of words conveying a complete idea and which has a Subject/Predicate relationship (Ryding, 2005). A hypotheses associated with this research is that the classification of the Arabic sentences might increase the performance of the Abdullah CITS by the CA component answering an utterance depending on its type (question or non-question). For a specific topic, a question-based utterance might need a correct answer to the question, while a non-question-based utterance might need an agreement or disagreement with the user's thoughts.

The AGDB represents information related to the specific language grammar such as whether the given sentence is a question or an exclamatory sentence (Monem et al., 2008). As an example, consider the user's utterance "what a beautiful day" which might be interpreted as a question sentence by a CA since it starts with a question word. However, Abdullah CITS when presented with this sentence considers it as an exclamatory sentence. This is based on a number of grammar rules stored in the grammar database which outline certain aspects of Arabic grammar. Abdullah's Arabic grammar database base contains a number of scripted adjectives such as (beautiful, nice, wonderful, and so on). When these adjectives are recognised by the engine as words that follow an exclamatory word (e.g. what) Abdullah's CITS engine is able to recognise this and considers this sentence as an exclamatory sentence. As part of this research, a number of features were designed specially to cope with the structure of the Arabic grammar, which are:

1. A non-question sentence analyser feature, for use within the Arabic CITS. This feature declare the role of the sentence analyser, by classifying the user utterances into either positive or negative sentences.

In Arabic grammar, the negative sentences are defined as sentences that have one or more Arabic negative words such as ("لا/No", "لن /Not"). Table 5.2 provides examples of Arabic negative sentences.

Negative word	Arabic negative sentence	English translation
لا	لا تلعب بالنار	Do not play with fire!
لن	كلبك لن يخونك ابدا	Your dog will never betray you
ليس	محمد ليس بطبيب	Muhammad isn't a doctor
لم	المشتري لم ير البيت الجديد البارحة	The buyer didn't see the new house yesterday

Table 5.2 Arabic Negative Sentences Example

The non-question sentence analyser allows the system to identify the correct response that should be delivered back to the user based on what the user is typing during the tutoring session.

A new grammar sentences classification feature was developed in order to understand the user's sentences. In the Arabic language, the interrogative words are used at the beginning of the sentences. These type of words are normally used when asking a question. Thus, the engine is able to recognise the interrogative words and classify the sentence as a question. Further information can be extracted from the sentence based on the other key words it may contain. Such as a sentence asking about a noun (because the sentence starts with one of the Arabic interrogative words whose), or the sentences might ask about a period of time (when the sentence start with interrogative word how long). For example utterance 1 in Table 5.3 , is an interrogative sentence, which asks about a noun because the sentence starts with one of the Arabic interrogative words (whose). Utterance 2 is an interrogative sentence asking about a period of time, and utterance 3, and 4 is a non-question sentences because it does not contain any interrogative word.

1	من هو نوح whose prophet Noah
2	How long did prophet Nuh preach his message كم دعى نوح قومه
3	I love to pray انا احب الصلاة
4	I don't like angels انا لا احب الملائكة

5.3 Abdullah CITS Arabic Grammar Classifying Example

The classification strategies used in Abdullah CITS goes even deeper than just classifying sentences; it can also show some understanding of the sentence.

2. Abdullah will assign a value of (P) for all sentences that are describing a good feeling (i.e. I love, I like, that is good, etc.), and a negative letter (N) to all sentences that are describing some bad feeling (i.e. I hate, I do not like, I feel nerves, etc.). Abdullah CITS classify the utterances similar to Al-Yaziji (al-Yaziji, 1989) which classifies the Arabic words according to the emotions, actions, and senses.

There is for example, a chapter in the Al-Yaziji book containing all the words that describe the emotion feeling "to love". All the words describing this feeling are separated by a comma as illustrated in Figure 5.6.

فصل في الحب

يقال أحببت فلانا ، ووددته ، وممقته ، وأعزته ، وصادقته ، وواليته ، وخاللته ، وأخيته ، وصافيته ، وخالصته . وقد صادقته الود ، وصافيته الود ، وخالصته الود ، وماحضته الود ، وأصفيته مودتي ، ومحضته مودتي ، وأمحضته مودتي ، وأخلصت له ولاني ، وصدقته إخواني ، وخصصته بمودتي ، واختصصته بمقتي⁸ . وان له موضعا من نفسي ، وله مكانا من قلبي ، وقد أشربت محبته ، وصغوت⁹ إليه بودي ، وأثرته¹⁰ بأعزازي ، واني لأحبه حبا صردا أي خالصا ، وله عندي ود مصفق¹¹ أي صاف ، وله عندي ذمة¹² لا تضاع ، وعهد لا يخفر¹³ ، وموثق¹⁴ لا ينقض . وهو حبيبي ، وصديقي ، وعزيزي ، وخليلي ، وأثيري ، وصفيي ، وأخي ، ووليي ، وحميمي ، وخلصي ، وخالصتي ، وخلصاني ، وسكني¹⁵ . وهو قرّة عيني ، ومنية نفسي ، ومحل أنسي ، وهو صفيي من بين إخواني ، وهو من خاصة خلاني ، وهو أخص إخواني ، وأقربهم مودة إلى قلبي . والقوم خلصاني وخلصاني ، وهم أهل مودتي ، وأهل ولاني ، وانهم لإخوان صدق¹⁶ ، وإخوان وفاء ، وانهم لمن أحب الناس الي ، ومن أعزهم علي ، وأكرمهم علي . وتقول قد تصادق الرجلان وتساهما¹⁷ الوفاء ، وتقاسما الصفاء ، وهما متصافيان على المحبوب والمكروه ، وقد تقلبت مع فلان في الشدة والخفض¹⁸ ، وشاطرته صرعي الرخاء والجهد ، وهو الصديق لا يذم عهده ، ولا يتهم وده ، ولا يهن¹⁹ عقده²⁰ ، ولا يخشى غدره . وبينني وبين فلان موثق ، وميثاق ، وعهد ، وذمة ، ونام ، وولاء ، وبينني وبينه جبل محصف²¹ ، وقد رسخت بيننا قواعد المودة ، وتوثقت عرى المصافاة ، واستحصفت أسباب الولاء²² ، واستحصدت مرائر الحب²³ ، وأمر¹ جبل الإخاء ،

1 الأرض الحارة

2 العود البعير المسن . والجرجرة الهدير يردده في حنجرته

3 حملا

Figure 5.6 A portion from Al-Yaziji book

Utterance 3 (I love to pray), which is illustrated in Table 5.3 describes some facts about the user, so Abdullah CITS will give a value of (P) to the first part of the sentence (I love), and gave a value of (P) to the second part (pray).

The final format for U3 (I love to pray) is (PP), and according to the Abdullah CITS Non-question sentence analyser, this sentence required an encouragement from the system as shown in Table 5.4.

PN	Need Correction response	Ex. Dear user you can't say that,
NP	Need Correction response	Ex. That is wrong ,
PP	Need Encouragement	Ex. Excellent , God pleased you
NN	Need Encouragement	Ex. Very good

Table 5.4 Abdullah CITS Non-question Sentence Analyser

Utterance 4 (I don't like angels), in Table 5.3 illustrated a bad feeling from the user, and for that case Abdullah CITS Non-question Sentence Analyser will give a classification of (N) to the first part (I don't like), and a classification of (P) to the second part (angels), so the finale classification format will be (NP) and that requires a correction also from the system, as illustrated in Table 5.4.

3. Abdullah CITS also implements the Quran word classification (Ahmad Maktar Abdullhamed 2002). Quran word classification classifies all the words with the same meaning into a number of groups as illustrated in Figure 5.7. For example assume that the user type in a question like “من هم الزبانية / whose alzzabaniya?”, Abdullah CITS will understand that the user is asked about a type of angels called “alzzabaniya”. Since the word, “alzzabaniya” is a synonym for angels that it is recognized and classified within the angel’s keyword.

١٢٨٠		فهارس قسم الألفاظ							
٢١٨٦	قَمِيص	١٧٩١	مُعَقَّبَات	٢٤٩٤	مُلَيَّع	٢٩٤٩	أَيْمَان ^٢	١١٢٨	يَزُول
٢٣٢٩	لِيَّاس	٢١٣٩	مُقَسَّمَات	٢٤٩٤	وَلَّه	٢٩٤٩	أَيْمَن ^٢		المقابلة
The Angels	المَلَك	٢٤٩٥	مَلَا	٢٤٩٤	يَمَلَا	١٦٠	أَيِّن	١٨٩	ب
	ذُو الْقُرْنَيْنِ	٢٤٩٩	مَلَائِكَة		المَلَائِكَة	١٦١	أَيَّمَا	٢٠٧٥	قُبُل ^١
Angels Word Synonyms	المَلَكِيَّة	٢٣٧١	مَلَقِيَّات	١٤١٠	أَشْهَاد	٧٠٠	حَيْثُ	٢٣٧٧	لِقَاء
	ذَات ^٢	٢٤٩٩	مَلَك ^٢	١٤٤٧	أَصْحَاب	٢٠٧٥	قُبُل ^٢	٢٣٧٥	مُلَاقُونَ
	ذَات ^١	٢٤٩٩	مَلَكَان	٢٩١٤	أَرْبَاب	٢٠٧٦	قَبِل ^٢		المقاربة
	ذُو	٢٥٣٤	مِيكَال	٢٣٤	بَرَّة	٦٥٩	مَجَل	٢٣٠٧	كَادَ ^١
Word reference in Quran	كَرَا	٢٥٧٩	نَارِعَات	٤٢٨	جِبْرِيَل	١٣٤٩	مَشْرَب ^١	٢٣٠٧	يَكَاد
	ذَوَاتَا	٢٦٠٣	نَاشِرَات	٥٠٢	جَن	٢٣١٠	مَكَان		المقاعد
	ذَوَاتَا	٢٦٠٧	نَاطِقَات	٦٤١	حَافِظُونَ	٢٩٤٩	مَيْمَنَة ^٢	١٢٠٠	سُرر
	ذَوو	٢٧١٩	كَارِوت	٥٨١	حَرَس	٢٧٦٦	هَتَالِك	١٧١٩	عَرَش
	ذِي	الملاحقة		٦٤١	حَفِظَة	٢٩٤٩	يَمِين ^٣		المقاومة
	قَبِيْضَة	٣٥٥	أَتْبَع	١٠٣٦	رَاقِي	المكانة		٥٠٧	جَاهَد
٢٠٦٨	لَدَى	الملازمة		٩٩٨	رُسُل	٦١٢	حُسْنَى	٢٦١٤	يَتَّصِر
٢٣٤٣	مَالِكُون	١٤٧٤	أَصْر	٩٩٨	رُسُول	٨٥٢	دَرَجَة		المقدار
٢٤٩٨	مَعَ	١٧٩٧	عَاكِف	١٠٠٤	رَصَد	٢٢٠٨	مَقَام ^٢	٢١٩٨	قَاب
٢٤٨١	مَلِك ^١	١٧٩٧	عَاكِفُونَ	١٠٦٥	رُوح ^٢	٢٨٤١	وَزْن	٢٠٩٢	قُدْر
٢٤٩٨	يَمْلِك	٢٢٠٨	قَائِم	١٠٨٦	رَاجِرَات	المكث		٢٠٩٢	قَدْر ^٢
	الممل	٢١٢٨	قُرْنَاء	١٠٨٣	زَبَانِيَّة	٢١٦٦	قَاعِدُونَ	٤٠٣	يُنْقَال
١١٤٥	يَسَام	٢١٢٨	قُرَيْن	١٣١٣	سَائِق	٢١٦٦	مُعَوِد ^١	٢٠٩٢	يُنْقَاد

Figure 5.7 Quran Word Classification

5.3.1.5. Facts Database

The Facts Database is a structured database which contains concrete facts about the Islamic religion (i.e. at the end of the month of Ramadan, Muslims have a three days Eid).

The Facts Database consists of three main parts, which are the individual facts (i.e. Haj fact, Eid fact, etc.), fact type (i.e. Islamic fact), and fact details (i.e. Muslims have three days Eid after Ramadan). However, there are three fact types, which are:

1. Islamic Facts

The Islamic facts contains information about the most common Islamic features, which relates to the main taught subject (The three fundamental principles of Islam). Table 5.5 illustrates the Islamic facts, which consists of a number of individual facts relating the Islamic facts such as the (the month of Ramadan, and the Angels).

Each individual fact has a number of associated details related to the main fact (i.e. three facts related to the month of Ramadan, and four facts related to the angels) (Justice, 2013).

Fact Type	Individual Fact	Fact Details
Islamic fact	The month of Ramadan	<ul style="list-style-type: none"> • Belonged to Hijree calendar. • Three days Eid after Ramadan. • Muslims have to fast in this month.
	<ul style="list-style-type: none"> • The angels • Gabriel • Michael 	<ul style="list-style-type: none"> • Allah created the angels from light. • Belief in angels is one of the six pillars of belief or faith. • They do not get bored or tired of remembering and worshipping Allah. • Whoever is an enemy to Allah and His angels and His messengers and Gabriel and Michael - then indeed, Allah is an enemy to the disbelievers.

Table 5.5 Islamic Facts DB

2. General Arabic Facts

The general Arabic facts contains information about the most common facts which related to either the Arabic language fact (i.e. facts related to the Arabic alphabet, and facts related to significant sites and places in Islam), or to the students behaviour (i.e. the rude words in the Arabic language).

The general Arabic facts contains a number of individual facts such as the list of Arabic countries names along with an explanation of these individual facts as shown in Table 5.6.

Fact Type	Individual Fact	Fact Details
General Arabic facts	<ul style="list-style-type: none"> • ق “Qaf” • ص “Saad” 	<ul style="list-style-type: none"> • It is an Arabic alphabetic letter. • It is a Quran chapter.
	<ul style="list-style-type: none"> • Iraq • Jordan • Syria • Yemen • Saudi Arabia 	<ul style="list-style-type: none"> • One of the Arabic countries. • One of the Islamic counties.

Table 5.6 General Arabic Facts DB

The user should not communicate in a rude or impolite way with Abdullah CITS for a number of times (the number of times values will be assigned by the scripter).

Abdullah CITS implement three levels of rude/impolite/inappropriate words, as shown in (Table 5.7). The scripter will assign a value of 1 to all rude words in level one, a value of 2 to rude word in level 2, and a value of 3 to all rude word in level three as shown in Table 5.7.

However during the conversation, Abdullah CITS will monitor the level of rudeness of the user to give the appropriate response or action (i.e. terminate the session) in the case of conversing using the rude words (Mairesse and Walker, 2010).

Fact Type	Level Number	Individual Fact	Fact Details
General Rude facts	1	<ul style="list-style-type: none"> • Donkey • Dog • Or silly word 	<ul style="list-style-type: none"> • Rude word (level 1) • Rude word (level 1)
	2	<ul style="list-style-type: none"> • Pig • Racism Words 	<ul style="list-style-type: none"> • Rude word (level 2) • Rude word (level 2)
	3	<ul style="list-style-type: none"> • Any swear words 	<ul style="list-style-type: none"> • Rude word (level 3)

Table 5.7 General Rude Facts DB

3. Little Facts

The little fact contains an answer for an utterances provided by the user that consists of two part which are the non-question and question parts.

To illustrate the little facts assume the user types in an utterance like “tell me please, why charity is so important to Muslims”. The first part of the utterance is classified as non-question (tell me please) while the second part classified as a question (why charity is so important to Muslims?). Initially Abdullah CITS consider the first part of the utterance, as a little fact and it needs a response from the system for that part. Abdullah CITS will reply to this fact by an appropriate answer as shown in the Table 5.8.

Abdullah CITS will also replay to the second part of the utterance “why charity is so important to Muslims?”, by a suitable response from CA scripts and then combine the two responses (little fact, and CA scripts responses) and delivered back to user as one response. The final response for the user utterance “tell me please, why charity is so important to Muslims” will be “Ok I will tell you, charity is important because it is the one of the Islamic pillar”.

The little facts database provides additional off topic and conversation related answer to utterances such as non-questions.

The researcher use knowledge of the Arabic language to include the most appropriate information that would help Abdullah CITS respond to non-questions more appropriately constructed the knowledge contained in the little facts database.

Fact Type	Individual Fact	Fact Details
Little facts	<ul style="list-style-type: none"> • Tell me please • Tell me the truth 	<ul style="list-style-type: none"> • Ok I will tell you, • No problem,
	<ul style="list-style-type: none"> • Tell me in the name of God, 	<ul style="list-style-type: none"> • Sure I will tell you,
	<ul style="list-style-type: none"> • Tell me if you love Muhammad, • Tell me if you love (Any name), 	<ul style="list-style-type: none"> • I will tell you, but please do not ask in any name except Allah.

Table 5.8 Little Fact DB

5.3.1.6. Arabic CA Scripts (CAS)

In order to provide dialogue for Abdullah CITS, it is necessary to create an Arabic CA, which in turn will require a new scripting language to be developed. The novel developed Arabic scripting language has been designed especially to handle both modern and classical Arabic language.

The Arabic CA scripts developed using the new scripting language reside in component 1 of the CITS architecture shown in Figure 5.3, but they will be discussed in more detail in section (5.3.2) in the context of the new Arabic Scripting language that has been developed.

5.3.2. Designing and Building an Arabic CA

The main component of the Arabic CITS architecture was the Arabic CA. The Arabic CA was designed and developed based on the number of features illustrated in section (5.2.1), to suite both versions of the Arabic language (MSA and CAL), and requirement for conversational tutoring. As described in chapter three, section (3.3.2.3), the pattern matching technique was used to handle the Arabic textual conversations, while the Arabic scripting language features were used to enable the scripter to script the full coherent domain. In addition to that, the short text similarity was used within the Arabic CA to enable the user to interact with the system using classical Arabic language (i.e. to extract verses from the Quran for discussion and further explanation of topics in the tutorial). The components of the Arabic CA are as follows:

1. The domain, of the Arabic CA which include :
 - a. Arabic CA scripts (section 5.3.1.6).
 - b. The Islamic DB (section 5.3.1.3).
 - c. Arabic Grammar DB (section 5.3.1.4).
 - d. Facts DB (section 5.3.1.5).
2. The Controller (section 5.3.2.5).
3. Conversation Agent manager (section 5.3.2.4).
4. Pattern Matching (PM) (section 5.3.2.1).

5. Short text similarity (STS) (section 5.3.2.3).
6. The Graphical User Interface (section 5.3.3.4).

5.3.2.1. The Arabic Pattern Matching Scripting Language

As described in Chapter 3, there are three different approaches to develop an Arabic CA (described in section 3.3.2), and a number of challenges faced by the Arabic language (were discussed in the literature review section 3.2.1). The literature review also highlighted the weakness in the only known Arabic CA ((Hijawi et al., 2014)). Through this research, it is concluded that the pattern matching approach is the most suited approach for the development of the Arabic CA (section 3.3.2.3). In order to represent any domain within Abdullah CITS, a new Arabic Pattern Matching Scripting Language had to be developed. Initial ideas for the language were taken from the Infochat scripting language which was designed to allow simple scripts to be developed in the English language (O'Shea, 2014). However, as discussed in section 3.3, due to the complexities of the Arabic Language it is not possible to build a like-for-like scripting language. In order to script the domain of teaching the three fundamental principles of Islam, the domain must be organised into a number of contexts (topics) where each contexts is responsible for a part of conversation related to a specific tutorial topic as illustrated in (Figure 5.4). Each context in the Arabic scripting language contained rules that have a pattern to represent the user input and an appropriate response from the specific domain. The rule is a sub topic of the context that the user might target during the tutoring session, while the pattern is a representation of that utterance which belongs to such rule. The pattern, which contains any collections of the Arabic words, spaces, and the wildcard symbols. The wildcard is used within the Arabic scripting language to match portions of the user's utterances. Each of these rules has a number of structured patterns to represent the expected user's utterance. A pattern can consist only of words, spaces, and wildcard symbols (i.e. *, %, #, etc.). Figure 5.8 presents an example on the Arabic scripting language, showing the main components of the scripting language, such as the context, rule number, rule name, pattern, and responses. Context 1 shown in Figure 5.8, shows three rules which are (charity, pray and the pilgrimage rules).

English Translation	Original Arabic Rules
Context: 1 Context Name : The Pillars of Islam	Context: 1 Context Name : أركان الاسلام
<p>RuleNumber:1 RuleName: About charity amount</p> <p>Pattern: How much do * to give to charity? Pattern: How much * charity? Pattern : what * charity amount * Pattern: What percentage * give to the poor or needy? Response: It is obligatory to give 2.5%</p>	<p>RuleNumber:1 RuleName: حول مقدار الزكاة</p> <p>Pattern: كم يجب أن * زكاة؟ Pattern: ما هو * زكاة المال؟ Pattern : * زكاة المال * Pattern: ما هي النسبة * للفقراء والمحتاجين؟ Response: النسبة هي 2.5%</p>
<p>RuleNumber:2 RuleName: About funeral prayer</p> <p>Pattern: What * funeral prayer? Pattern: what * Salat-al-Janazaa? Response: The prayer is performed in congregation to seek pardon for the dead Muslims</p>	<p>RuleNumber:2 RuleName: حول صلاة الجنازة</p> <p>Pattern: ما المقصود * بصلاة الميت؟ Pattern: ما المقصود * بصلاة الجنازة ؟ Response: هي الصلاة التي ترحى فيها المغفرة لموتى المسلمين</p>
<p>RuleNumber:3 RuleName: About pilgrimage</p> <p>Pattern: Why is Hajj * to Muslims? Pattern: what * from hajj? Response: It teaches us that Muslims are brothers and are equal</p>	<p>RuleNumber:3 RuleName: حول الحج</p> <p>Pattern: لماذا الحج * للمسلمين ؟ Pattern: ماذا * من الحج ؟ Response: الحج يعلمنا كمسلمين بأننا اخوة ومتساويين</p>

Figure 5.8 Scripting language

Wildcards are used within patterns to match any number of words within the utterance. In Figure 5.8, patterns contain the wildcard symbol (*) that matches any number of words.

In order to match a human utterance to a rule the following procedure is followed:

1. At the start of a new session, an initial context is set as the starting point of the discussion/tutoring session. This context is selected at random.
2. A natural language utterance is received from the user, and it is matched to one of the patterns that are related to a rule in the initial context.
3. The rule with the highest activation level will fire, the activation level of the rule (RAL), will be calculated depending on three parameters which are, the pattern strength, pattern compactness, and a multiplier value for matching strength. Each of these parameters will be described now:

- a. Pattern strength (PS), which can be measured based on the number, and positions of the wildcards in the pattern (Michie and Sammut, 2001b). The pattern strength can be illustrated in the following equation (Equation 1).

$$PS = 1 + (\text{Number of stars in the pattern} \\ - (\text{Number of leading stars} \\ + \text{Number of trailing stars})) \\ + (\text{Number of clear ends} \\ + \text{number of blanks next to star}) \\ + (\text{Number of blanks between patterns} \\ * \text{number of blanks not next to star})$$

Equation 1 Pattern Strength

- b. Pattern compactness (PC), defined as the length parameter for computing compactness (Michie and Sammut, 2001b). The pattern compactness can be illustrated in the following equation (Equation 2).

$$PC = \frac{\text{Last length of utterance needed for match}}{\text{Actual length of the matched text}}$$

Equation 2 Pattern Compactness

- c. The multiplier value for matching strength (K), which could be either a value of zero if there are no matching with the patterns, or a fixed value of (0.1) if there are a matching with the patterns (Michie and Sammut, 2001b). The rule activation level can be measured using the following equation (Equation 3).

$$RAL = PS * PCOM * K$$

Equation 3 Rule Activation Level

4. The matching process will continue until all rules of the current context are processed. Once the matching is occurred, and the rule been fired it will links the current context to another context, and let the engine to start matching of the new contexts.

For each matched rule in the current context, the activation level is calculated. If there are no matching rules with the current context, the conversation manager (described in section 5.3.2.4), will switch from the current context to another context for further matches with the new other context patterns.

5.3.2.2. The Arabic Pattern Matching Scripting Language features

The Arabic scripting language has a number of features that enables a scripiter to script the domain, the features of the Arabic PM will be explained in detail in the following sections.

5.3.2.2.1. Rule condition feature

Rules within the Arabic scripting language may contain conditions. A condition is defined as a variable that is been assigned to a rule by the scripiter, and the condition of that variable has to be met before a rule can be fired.

The rule condition is controlled by the condition value (a value of zero if the rule has no condition, and a value of one if the rule has a condition).

To illustrate this feature, assume the user types in the following utterance (What is the first type of monotheism?), as shown in Figure 5.9. This utterance will match with both rule number one and rule number two, but the system will let rule number one to fire first because rule number one has no condition before firing (condition value set to zero). Rule number two has a condition that has to meet before firing, which is to run rule number three first.

<p>RuleNumber:1 Rule Name: First type</p> <p>Pattern : what is the first type * Pattern : * what is the first type Pattern : the first type *</p> <p>Response: do you know what is the meaning of #</p>	<p>RuleNumber:2 Rule Name: First type of Monotheism</p> <p>Pattern : * first type of monotheism Pattern : what is the first type of monotheism * Pattern : * monotheism * first *</p> <p>Response: <i>Belief in the Oneness of the Lordship of Allah</i></p>
<p>Condition value: 0</p>	<p>Condition value: 1 Condition Text : Run rule number 3 first</p>
<p>RuleNumber:3 Rule Name: Meaning of Monotheism</p> <p>Pattern : * meaning of Monotheism Pattern : * meaning of Monotheism in Islam Pattern : what * Monotheism Pattern : what * Monotheism in Islam Pattern : what * Monotheism * Pattern : Monotheism * religious Response: is the belief in the existence of one God, and there are 3 types of Monotheism.</p>	
<p>Condition value: 0</p>	

Figure 5.9 Rule condition example

In Figure 5.9, it can be seen that the Arabic CA wants the user to know the meaning of monotheism before asking further detailed questions (like what the first type of monotheism). After firing rule number one, the conversational manager will increase the activation level of rule number three, so it will have a great chance of firing to ensure the user understands what the meaning of monotheism is. This will ensure the student understands the concepts presented to them during the tutoring session.

Once rule one has fired the condition in rule number two will be met, and if during a conversation the user targeted rule number two it will fire and an appropriate response will, sent back to the user.

5.3.2.2.2. Ability to capture variables

The Arabic CA has a novel feature, which allows capturing a variable such as (names, places, dates, facts, etc.) from user utterance. The Arabic CA can extract a number of variables (a maximum of three in one utterance), during the conversation, by capturing all the matched word in rule.

Consider the user will type in an utterance like “Why did God send Adam, Ibrahim, and Muhammad”, this utterance will match with the rule number one as shown in Figure 5.10. The CA will extract the variables (Adam, Ibrahim and Muhammad), using the short text sentence similarity. Short text sentence similarity will match the keywords from the utterance to the facts table where the prophet’s names are stored, and then check it with the Islamic facts that has been stored in the fact DB (illustrated in section 15.3.1.5).

Therefore, Adam will be assigned to var1, Ibrahim assigned to var2 and Muhammad will assigned to var3 as all these names are stored in the facts database. Once the variables values have matched with the fact databases, the CA will generate the response such as (God sent Adam, Ibrahim and Muhammad to guide humanity).

<p>Rule Number: 1 Rule Name: why God sent prophet Pattern: why God sent * Pattern: why God sent * to people Pattern: do you know how is * Response: God sent # to guide mankind</p>	<p>RuleNumber:2 Rule Name: prophet Muhammad companion Pattern : whose * Pattern : in Islam , whose * Response: The companions of Muhammad, who had met or had seen prophet Muhammad</p>
<p>Condition value: 1 Condition text: 1. Capture variables 2. Found match in Islamic Facts DB (Prophets table)</p> <div data-bbox="360 1014 876 1294" style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>User Utterance example: Why did God send <u>Adam</u>, <u>Ibrahim</u>, and <u>Muhammad</u>?</p> <p style="text-align: center;"> ↑ ↑ ↑ Var1 Var2 Var3 </p> </div>	<p>Condition value: 1 Condition text: 1. Capture variables 2. Found match in Islamic Facts DB (Prophet's Muahmmad companions)</p> <p>RuleNumber:3 Rule Name: Angels Pattern : Why God sent * to prophet Pattern: Why God sent * in the battle of Uhad. Response: angels have been created to worship Allah and carry out His commands.</p> <p>Condition value: 1 Condition text: 1. Capture variables 2. Found match in Islamic Facts DB (Angels of God table)</p>

Figure 5.10 Capturing variables example

5.3.2.2.3. Adaptation of CA response based on user ability

In order to deal with different abilities and knowledge levels of students, Abdullah CITS implements a new feature that aims to classify the knowledge level of the user. The levels of user's knowledge is split into three distinct levels; these are default, low level, and high level (Gong et al., 2009).

The normal conversation responses (or the default), which have been designed to suit students with the normal level of knowledge relating to the curriculum for that given age range. The other set of responses are divided into two main groups that is the high level (Advanced responses) and low level (basic responses). The low level type of responses are designed to suit students with a low level of Islamic knowledge and that type of responses has associated pictures as well as other accompanying media associated with it (i.e. pictures, and videos). This media will be used to give the user more illustration about a particular subtopics to help them understand (Sottolare et al., 2013). The rules within a context are organized into either tutoring rules (rules that belong to the tutoring context), or general rules (rules that do not belonged to the tutoring context). During a tutorial session, the user utterances/responses are matched against the stored answers in the tutorial knowledge base. These stored answers (or the preferred answers), were derived in the knowledge engineering stage through interviews with Islamic school's teachers (see section 5.3.1.2 knowledge engineering). The preferred answers can be simple or complex depending on the question and can contain a verse from the Quran or Hadith. These preferred answers are what Abdullah CITS expects as answers from the user/student (illustrated in Table 5.9).

Abdullah CITS classifies the answers into three categories which are low (i.e. one word answer), medium (i.e. an answer contain two or more words), and high answers (i.e. an answer with a verse from Quran or Hadith). The process that Abdullah CITS follows to match the user utterances is as follows:

- 1- The answer from the user will be matched with the preferred answers in the TKB. Abdullah CITS will than assign a value to the users answer based on the degree/level it matches to the stored preferred answers in each of the classification categories, the values assigned equate to the following:
 - Between 40-60 is a low preferred answer.
 - Between 60-80 is a default preferred answer.
 - Between 80-100 is an utterance that contains a related verse from Quran, or Hadith (high or perfect answer).

2- In addition to the matching with the preferred answer, Abdullah CITS is able to deal and classify the answers/utterances that are not directly related to the tutoring content (i.e. the utterance is not an answer to the question asked by Abdullah CITS). Abdullah CITS will be assigned a score of:

- Fifty when the tutoring session starts. Every student is assigned a default score value of fifty for the first question in tutoring session. This value will be stored in the student model. This score value is then adjusted based on the subsequent answers given by the user, which will then adapt the session to either a high level or low level based on the user's responses.
- Forty is assigned to the student model if the user gives an answer that is not directly related to the question but is still relevant to the topic of tutoring (i.e. it is related to an Islamic subject and it matches to a preferred answer in a different tutoring context).
- Thirty is assigned to the student model if the user type in an utterance like (I do not know, I am not sure, type answers). However If the user keeps repeating the same utterances (I do not know, I am not sure, etc.), then Abdullah will assign a value of 10 to the repeated utterance of this nature.
- Zero is assigned if the user gives answers that does not belong to the current context.

3- Based on the scores stored in the student model, Abdullah CITS will compute the average for the user's answers in each context (each context contains a number of subtopics between 3 – 5). Then when the tutoring context is finished and switched to a different context, Abdullah CITS will compute the average score between the previous context and with the score obtained from the first question by the user in the new context/topic. This average calculation is conducted whenever the user/student transfers from one context to another. The value of the average score will determine the level of questions (Default, High and Low) presented to the student/user in that particular context.

The matching with the preferred answer will ensure that the user will receive the best answer from Abdullah CITS and will be presented questions and enforcements that are suitable to the detected level of user's knowledge. The Abdullah CITS STS measure is responsible for matching the user utterances to the preferred answers in the TKB (described in section 5.3.3.1). The STS measure will calculate the matching strength of the user utterances to the stored preferred answers, and the answer, which has the highest matching strength with the utterance, will be utilised for the score given to that particular user utterance. The process of how responses are generated and delivered during the tutoring is as follows:

1. The default level response consist of two parts, which is the default response (i.e. the answer to the question), as well as relevant accompanying media such as (photo, or sound). The simple response is be generated in the following conditions:
 - A match to the low level answers in the preferred answers tutorial knowledge base. As discussed earlier in this section a match to a low-level answer, will results in a value of 40 – 60 being assigned to the student model depending on the matching strength of the answer to the preferred low-level answer stored in the TKB.
 - When the user types in an utterance like “I do not know “consecutively in a specific tutoring context. Then Abdullah will assign a value of 10, as shown in (subtopic 3 in Table 5.9).
 - An accumulative average less than 50 in the previous context, and a match of 40–60 with the low answers of the TKB in the following context.
 - Subtopic 5 in Table 5.9 shows that Abdullah CITS computes the average score of the previous contexts as “45”. In the first subtopic of the following context, the user scores an answer of “60” which is a default level score. However, because the running average of the two scores is “52.5” which fall into the low-level category it means that the low (simple level) response is delivered back to the user as the system detects that the student is struggling with the tutoring content based on the calculated average score. If in the following questions the user scores highly then the average score will be raised and the tutoring session will be altered to the high level in the next context, as the student will be demonstrating more understanding.

2. The default response, is a response without classical Arabic language (Quran verses, or Hadith), and without any illustrated media (photo, or sound). An example where the default response can be generated and delivered is outlined in the following conditions:
 - If the user types an utterance like (I do not know, or I am not sure), the default response will be generated and delivered to the user, and Abdullah CITS will assign a value of 30 as the score in the student model, as shown in (subtopic 2 in Table 5.9). However, if the user types in the same utterance (I do not know), more than once the simple response will be generated at that time also. If the user keeps typing the same utterance (I do not know), repeatedly Abdullah CITS will assume that the user is having some difficulties in understanding the current tutoring question. Then Abdullah CITS will restart the current context from the beginning with the low-level question, in order for the tutorial questions to be refreshed and represented to the user in a more simple style.
 - Subtopic 4 in Table 5.9), show that Abdullah CITS assigned a value of 60 for the user utterance matching with the default perfect answers. Based on the calculated accumulative average (45) the following context (context 2) will be presented to the student with low-level question and content.
3. The advanced response is a response from the user that consists of two parts, which is the basic response (i.e. high-level preferred answer), and a classical Arabic language sentence/s (Quran verse, or Hadith). The advanced response can be generated in these conditions:
 - If Abdullah CITS assigns a value of 80 or over for the user, utterance that will match to the High preferred answers stored in the TKB. These utterances will contain the preferred answer as well as an appropriate verse from the Quran or Hadith illustrated in subtopic 1 in Table 5.9).
 - A higher value between 80-100 will be assigned depending on how close the verses quoted by the user is to the selected verse stored in the knowledge base (see section 5.3.2.3 for short text sentence similarity).

Table 5.9 shows an example of a tutorial session with the user “Isra”, who was taught by Abdullah using the second branch of Islam (to know your religion). The example illustrates the tutoring flow between the user “Isra”, and Abdullah CITS. Table 5.9 will shows the response generation delivered by Abdullah CITS. The first column (Abdullah CITS Questions) illustrates the question that has been asked by Abdullah during the tutoring session, as well as the answers provided by the user. The second column contains all the preferred answers in the tutorial knowledge base, showing the three levels of classification (low, medium, and high). The third column shows the score given by Abdullah CITS for each of the users answers/utterances (e.g. 40-60%, 60-80%, and 80,100%) based on the matching strength calculated by the STS measure.

The fourth column states the exact value given by Abdullah CITS which is then stored in the student model. Finally, the last column shows the preferred responses given by Abdullah, as well as the level of responses (low, default, and advanced response). In addition, Table 5.9 shows how Abdullah CITS calculates the running average of the current context, by adding the score obtained in each subtopic and dividing it by the number of subtopics in the context (accumulative average).

The student’s knowledge will be measured during the tutorial by a number of variables detailed in (Chapter 6 Section 6.3.1), such as the percentage of the correct answers, whether or not the students asks a question related to the main topic, and if the students provided any information using classical Arabic language (i.e. a verse from Quran or Hadith).

During a tutorial, Abdullah CITS will direct the learner either by using the default or detailed response after each utterance, as shown in Table 5.9. The STS measure calculates the similarity of the user’s utterances (see section 5.3.2.3 for short text sentence similarity) to the preferred stored answers, and utilises these similarity values to provide the appropriate response back to user. Table 5.9 shows that after the user has a default response in the second iteration, Abdullah CITS will present the next tutorial context (context 2) questions and answers in the low level.

Abdullah CITS Questions	Perfect answers from tutorial knowledge base		Scores giving by Abdullah	Student Model	Abdullah CITS responses
<p>Abdullah: Can you tell me the greatest obligations, we must do every day?</p> <p>Isra: Salah, Allah Said Those who are constant in their prayer</p> <p>Subtopic 1</p>	Low	1. Salah 2. Pray	40-60%	80	<p>Abdullah: excellent God blessed you, performing the five daily prayers. (And establish prayer at the two ends of the day and at the approach of the night. Quran 11-114).</p> <p>Advanced Response</p>
	Medium	3. five daily prayers	60-80%		
	High	4. Any related Quran Verses or Hadith.	80-100%		
<p>Abdullah: Salah It is the only pillar that Muslim can do it in any conditions, who is that?</p> <p>Isra: I Don't Know</p> <p>Subtopic 2</p>	Low	1. disabled + pray 2. disabled + Salah	40-60%	30	<p>Abdullah: a person who cannot stand or sit down can pray while lying down by moving his head.</p> <p>Default Response</p>
	Medium	3. A person who cannot stand have to pray. 4. A person who cannot stand can pray while lying down by moving his head.	60-80%		
	High	5. Any related Quran 6. Verses	80-100%		
<p>Abdullah: God has stressed the importance of prayer, do you know why?</p> <p>Isra: I Don't Know</p> <p>Subtopic 3</p>	Low	1. Judgment day + Pray 2. Day after + Pray	40-60%	10	<p>Abdullah: Prophet Muhammad said, "The first thing will be held accountable for on the Day of Judgment is prayer."</p> <p>PERFORM SOLAH BEFORE OTHERS SOLAH FOR YOU.</p>  <p>Simple Response</p>
	Medium	3. First thing will be held on the judgment Day is prayer. 4. All Muslim actions will not count without Praying.	60-80%		
	High	5. Prophet Muhammad said "The first thing one will be held accountable for on the Day of Judgment is Prayer." 6. Related Quran verses	80-100%		
<p>Abdullah: Do you know how much prostration to God in a day during prayers, or (who many Rakaahs does the Muslim do every day?)</p> <p>Isra: 17 rakaahs</p> <p>Subtopic 4</p>	Low	1. 17 2. Seventeen	40-60%	60	<p>Abdullah: very good, the Number of Rakaahs that are performed in the 5 Daily prayers is 17.</p> <p>Default Response</p>
	Medium	3. 17 Rakaahs 3. The Number of Rakaahs that are performed in the 5 Daily prayers is 17.	60-80%		
	High	4. Any related Quran verses	80-100%		
Context 2			Context1 (Average = 45%) $\frac{(90+30+10+50)}{4}$		
<p>Abdullah: Do you know what the second pillars of Islam is, and it is related to money?</p> <p>Isra: almsgiving</p> <p>Subtopic 5</p>	Low	1. Almsgiving 2. Zakat	40-60%	55	<p>Abdullah: excellent, Zakat is the second pillars of Islam.</p>  <p>Simple Response</p>
	Med	3. The pillars of Islam.	60-80%		
	High	4. Any related verses from 5. Quran	80-100%		

Table 5.9 Response Generation Example

5.3.2.2.4. Macros feature in Arabic scripting language

The Arabic scripting language uses macros to reduce the number of scripted patterns and thus improve the maintenance of the Arabic CA. When there is a different rule in a different topic that has the same set of patterns, macros are used to script the patterns only once, and assign a macro number to the rule that utilises these patterns in the different topic, which saves the scripter having to script the same patterns repeatedly.

Table 5.10 illustrates the macro feature; rule number 1 (About a person) has two macros (Prophet's macro, and prophet Muhammad_ companion's macro). Each of these macros has a number of values associated with it (i.e. the prophet's macro contains a list of the prophets mentioned in the Quran such as, Adam, Noah, Muhammad, etc.). The macro also has a response to send back to the user when the user utterance matched to the keyword in the pattern. To illustrate the macro feature assume that the user types in an utterance like (Who is Ali?). It will match with pattern "Who is *".

The system will capture the variable "Ali" from the utterance, which will be extracted from the utterance and checked with the assigned macros. The system will then generate the appropriate response and send it back to user. In the example (Who is Ali?), the response returned by the CA is (Ali is prophet's Muhammad son in law).

However, in the case that there are no match with all the assigned macros the default system response will be delivered back to user, which in this example is: (I do not know who Ali is).

RuleNumber:1 Rule Name: About a person Pattern : who's * Pattern : who's ** Pattern : is it God sent # Pattern: is it God sent # *. Pattern : do I have to believe in # Pattern : do I have to believe in #* Macro : 1-Prophets 2-Muhammad_ companions	Responses	
	Macro Keyword	Prophets Macro's Responses
	Adam	Prophet Adam: he is the first human
	Noah	Prophet Noah: Noah build the Ark
	Muhammad	Prophet Muhammad: Last prophet
	Macro Keyword	Prophet Muhammad companion's Macro responses
	Ali	Prophet Companions: The name of the Prophets son in law.
	Omar	Prophet Companions: Omar bin Al-khattab was a sahabi and 2'nd Khalifa,
	Normal Responses	
	I don't know how is #	

Table 5.10 Macro feature

5.3.2.2.5. Rules with Dynamic Information

The new Arabic scripting language has the ability to retrieve dynamic information offered by the user during the dialog, by calling a function called RunSQL. RunSQL sends a request query to the Islamic database (i.e. Quran or Hadith table), and then the system sends the result obtained from this dynamic query back to the user. The RunSQL feature is designed with the intention of satisfying dynamic user queries concerning the content of the Quran and Hadith. This feature enhances the teaching by allowing the responses to contain actual locations of specific text within the Quran, which is especially useful for teaching the Quran. This feature can give an actual reference to the specific question, which the student/user can then go, and look up for themselves within the Quran itself. The RunSQL can emulate a classroom teacher who uses verses from the Quran to illustrate examples such as honouring one's parents, and the importance of worship and being positive in life (Aldour, 2013). It serves a methodology of teaching which is similar to repetition, reiteration and use of examples in the teaching of Islamic subjects (Mohd Othman et al., 2011).

The intention of using this type of specific response to the user question is to ensure that the answer is unambiguous and leaves the user with a reference, which they can go away and read after the tutoring session has ended. The query results that are embedded in the response can be seen in Figure 5.11.

```

Rule Number: 3
Rule Name: QuranSQL_how many

Pattern: How many times the word * repeated
in Quran
Pattern: in Quran the word * repeated *
Pattern: * repeated in Quran
Pattern: * repeated * Quran

Response : the word # is not in Quran
RunSQL: select count(word) form Quran Table;

```

Figure 5.11 RunSQL example

Assume that a user types an utterance like: “How many times is the word Muhammad repeated in the Quran?” it will match with the patterns in the rule name (QuranSQL_How many).

The Arabic CA will extract the word ‘Muhammad’ from the utterance and then use it via RunSQL to get the response. When rule number three is fired (Figure 5.11), an integer value will be returned if there are a matched in the Quran table (the integer value indicate the number of occurrences of the queried word in the Quran table).

However, If RunSQL returns a null value, this means that the word is not in the Quran and then the CA will display the default response, which is “the word *user word* is not in the Quran”.

The RunSQL feature has another rule that deals with the exact location of such a verse in the Quran along with the page number where the verse can be found. In addition to this, the translation of that verse from the Tafsir (Al-Sabuni, 1981), is also retrieved and conveyed to the user when the user requests an explanation of that verse from Abdullah CITS.

5.3.2.3. Short Text Similarity (STS)

As discussed in Chapter 3 Section 3.3.2.2, STS measures are used to determine the similarity between two strings of text, it have been showed a good effect in English CA's (O'Shea et al., 2010). A STS measure has been developed for Abdullah CITS in order to match user utterances to the classic Arabic language. Classical Arabic is rarely spoken these days in communication. Therefore, it can be safe to conclude that generally, user utterances will be received in MSA; therefore, PM is not a suitable method for matching user utterances in MSA to knowledge base resources that are in the CAL. According to the researcher, there is only one Arabic STS measure in existence, which is still under development (Almarsoomi et al., 2012), and there for it is not suitable for implementation into Abdullah CITS. In order to match the similarity between MSA and CAL a new Arabic STS measure has been researched, developed and implemented into Abdullah's CITS architecture. The developed Arabic conversational agent incorporates string similarity algorithms in a novel way to determine the similarity between user utterances and the TKB resources, as well as Islamic resources (such as Quran, and Hadith). The developed STS measure is based on principles of string similarity. String similarity is concerned with the lexical similarity between two strings, examples of such measures are:

- Jaccard coefficient similarity (Niwattanakul et al., 2013), explained in section 5.3.2.3.1.
- Dice coefficient similarity (Thada and Jaglan, 2013), explained in section 5.3.2.3.2.

5.3.2.3.1. Jaccard coefficient similarity

The Jaccard coefficient measures similarity defined as the size of the intersection of the words in the two sentences (known as S1, and S2), divided by the union of the words in the two sentences (Akermi and Faiz, 2014).

$$Jaccard_{1-2} = \frac{S1 \cap S2}{S1 \cup S2}$$

Equation 4 Jaccard Coefficient Equation

To illustrate the Jaccard coefficient similarity, assume the user utterance during the conversation was (S1), while the stored answer in Abdullah CITS was (S2), as illustrated in Table 5.11.

<p>User Utterance:</p> <p>S1 = (استخدم ابرهة جيش من الافيال فلما وصل جيش ابرهة) (مكة)</p>	<p>S1 = (Abraha uses an army of elephants, and when they arrived to Mecca)</p>
<p>Stored Answer in Abdullah CITS:</p> <p>S2 = (جاء ابرهة ومعه جيش كبير تتقدمه الافيال لهدم الكعبة في مكة)</p>	<p>S2 = (Abraha came with a large army that includes elephants, to demolish Al Kaaba in Mecca)</p>
<p>$|S1 \cap S2| = 4$ $|S1 \cup S2| = 17$</p>	

Table 5.11 Jaccard coefficient similarity Example

Equation 5 shows the result obtained from Jaccard equation when applied to S1 and S2, which in this example is equal to 0.23.

$$Jaccard_{1-2} = \frac{S1 \cap S2}{S1 \cup S2} = \frac{4}{17} = 0.23$$

Equation 5 Jaccard Coefficient Equation Example Result

5.3.2.3.2. Dice Coefficient

Dice coefficient similarity is very similar to the Jaccard similarity measure and is also often used in information retrieval (An and Hagiwara, 2014). The definition of the Dice Coefficient similarity is as follows:

$$Dice\ Coefficient_{1-2} = 2 \frac{S1 \cap S2}{S1 + S2}$$

Equation 6 Dice Coefficient Equation

By implementing this algorithm to measure the similarity between the two sentences, S1 and S2 illustrated in (Table 5.11), the result obtained from the Dice coefficient was (0.38) as shown in Dice coefficient equation example (Equation 7).

$$\text{Dice Coefficient Example} = 2 \frac{|S1 \cap S2|}{|S1| + |S2|} = 2 * \left(\frac{4}{10 + 11} \right) = 0.38$$

Equation 7 Dice Coefficient Example

5.3.2.3.3. Arabic Short Text Similarity (ASTS)

The new Arabic ASTS is developed using a combination of the principles implemented in the Jaccard and Dice Coefficient algorithms.

The ASTS measure uses the string intersect and union principles from the Jaccard algorithm and takes into consideration the number of words in each string to be matched. The combination of Jaccard and Dice string/sentence similarity principles made the ASTS measure more robust and accurate at measuring the similarity between the user utterances and Islamic knowledge base resources. As mentioned earlier there is no Arabic STS measure in existence. The intention behind the development of ASTS is to bridge the gap between MSA and the CAL as pattern matching is not suitable to deal with matching user utterances with Islamic knowledge base resources.

The Arabic short text similarity was developed for extracting responses from texts such as the Quran, and Hadith, for discussion and further explanation of topics in the tutorial. The ASTS measure is used in Abdullah CITS when the user utterance fails to match with the patterns in the scripts developed using the Arabic scripting language. This technique ensures that the user has more chance to get a response more relevant and appropriate to the tutoring session (i.e. users could have responses from the Quran or Hadith if there are no match with the Arabic scripting language).

The developed ASTS measure used in Abdullah CITS works by counting the number of matching words in the first sentence ($S1$) that are also found in the second sentence ($S2$). The same is then done for the words that match words in the second sentence compared to the first sentence.

Then these two values are divided by the total number of words in both sentences, multiplied by 100, which will give the percentage of similarity. As illustrated using Equation 8.

$$Similarity_{1-2} = \frac{(S_{1-2} + S_{2-1})}{T_{1\&2}} * 100$$

Where:
 S_{1-2} = the total words of sentence 1 found in sentence 2
 S_{2-1} = the total words of sentence 2 found in sentence 1
 $T_{1\&2}$ = the total words of both sentence 1 and 2

Equation 8 Arabic Short Text Similarity (ASTS)

Figure 5.12, illustrates an example using the ASTS to measure the similarity between two sentences. The ASTS measure works by counting first the number of words that found in sentence number one (S1), and found in sentences number two (S2), which are in this example equal to six ($N_{1-2} = 6$). Secondly, compute the words in the second sentence compared to the first sentence, which are equal to four ($N_{2-1} = 4$). Finally divided the totals from (N_{1-2} and N_{2-1}) by the total words in both sentences ($T_{1\&2} = 21$).

S1 (استخدم ابرهة جيش من الاقيال فلما وصل جيش ابرهة مكة)
 S2 (جاء ابرهة ومعه جيش كبير تتقدمه الاقيال لهدم الكعبة في مكة)
 $N_{1-2} = 6$ $N_{2-1} = 4$ $T_{1\&2} = 21$
 $Similarity_{1-2} = (6+4) / 21 * 100 = 47.62 \%$

Figure 5.12 ASTS - Example

It can be seen from the example (Figure 5.12), that the ASTS is able to calculate a stronger match (47.62%) of the example utterance and the classical Arabic language resource (Hadith) when compared to the Jaccard measure (Table 5.11, and with a match equal to 23%), and the dice coefficient (Equation 7, and a match equal to 38%).

5.3.2.4. Conversation Manager

The role of the Conversation Manager (CM) is to manage the flow of the conversation and the tutoring session in the TKB (see section 5.3.3.1). The CM will responsible for directing the user through the tutorial by monitoring the user's answers or questions/fired rules to ensure the learning outcomes (the goal of the tutoring session) are achieved by ensuring the conversation follows the required path between the tutoring contexts.

The CM also controls the conversation context and it is responsible for changing the contexts as required depending on the user's utterances. The CM is used within the Arabic CA to:

A. Managing the contexts

Managing context consider one of the most important features for the Arabic CA, to solve the ambiguity of using the diacritical marks within the conversation, as discussed in section (3.3.1.1.1). If the current context does not yield any matches with the user utterance, then the CM can move the current context of the conversation to another context (according to the learning goal) to continue matching the user utterance with different contexts to check if a match exists.

The conversation starts with the user by taking the user utterance to a different process depending on the type of utterance, and finally generates the most suitable response according to the matching algorithm and delivers the response back to user. Figure 5.13 shows a flow diagram of how each user utterance is processed. The CM will pass the user utterances through different process/stages, as follows:

1. The user's utterance will first pass through the utterance validation process (defined as number 1 in Figure 5.13). The user utterance validation process is the first task done by the controller (defined in more detail in section 05.3.2.5).
2. Once the utterance has been declared valid, the second process is to classify the utterance based on its grammar structure (defined as number 2 in Figure 5.13). The utterance is classified either as question utterance (a type of utterance starting with an interrogative word), or a non-question utterance (an utterance that does not contain an interrogative word), as described in section (5.3.1.4). The other possible classification of the utterance are the utterances that contains an interrogative word, but it is not a question-based utterances. Based upon the classification three possible directions could be followed:

- I. Classification is a question-based utterance. In this case, the conversation manager will try to find a match within the Arabic CA scripts (defined as number 12 in Figure 5.13). If the match occurs, the conversation manager will generate the response and send it back to the user (defined as number 13). An example of this kind of response are illustrated in Table 5.12 (Response C). However if there is no match, the conversation manger will check with the Quran (number 8) for further matching.
- II. Classification is a non-question utterance (i.e. a statement, or an answer to a question). In this case, the conversation manager will try to find a match with the tutorial knowledge base answers (defined as number 3 in Figure 5.13). Once a match been found, the conversation manger will generate the response and deliver it back to the user (number 4). An example of this kind of response are illustrated in Table 5.12 (Response A). If there is, no match with the stored answers in the tutorial knowledge base the conversation manager will try to find a match within the facts database defined as number 5 in Figure 5.13, and facts DB, illustrated in section 5.3.1.5. If a match occurs, the CM will generate the response and send it back to the user (number 6). An example of this kind of response are illustrated in Table 5.12 (Response B). However if there is no match with the stored answer the conversation manger will match the utterance with entries within the Quran database (number 8) for further matching.
- III. Classification is a non-question plus a question (i.e. I do not understand, what do you meant by the monotheism?). In this case, the CM will spilt the utterance into two parts, which are the question, and non-question (defined as number 14 in Figure 5.13).

The question part will be matched with the Arabic CA scripts to find a match (number 12), and if there is no match the CM will check with the Quran database (number 8). In addition, the non-question part will be checked in the little fact database (defined as number 15 in Figure 5.13, and little facts DB, illustrated in section 5.3.1.5), and if the match is found, the CM will generate the response (number 16). An example of this kind of response are illustrated in Table 5.12 (Response E). In the case that there are no match with the little fact database the CM will move the non-question part for a further match in the stored answers database (number 3).

3. The CM will utilize the ASTS in order to match the user utterance with the Arabic CA scripts, or with the stored answers in the knowledge base. However, in the case that there are no match with these sources the CM will then check the utterance with the Islamic database sources, which is described as follow:
 - I. To check with the Quran database, which is defined as number 8 in Figure 5.13. If a match occurs, the Islamic DB response generation (number 21) will extract the verses from the Quran and add the correct Quran response (number 9).
 - II. To check with Hadith database, which is defined as number 10 in Figure 5.13. If a match occurs with this DB, the Islamic response generation will extract Hadith and adding it into the right figure (number 9). An example of this kind of response are illustrated in Table 5.12 (Response D).
 - III. If there is no match with the Quran DB or Hadith DB (number 20), the CM will send an appropriate default response back to user such as “I am sorry but I can’t understand you”. Then the CM will wait for the next user utterance to be entered.

Response Type	Response Example
Response A	Abraha came with a large army that includes elephants to demolish the Kaaba in Mecca.
Response B	Excellent, the praying is one of the most important pillars of Islam.
Response C	Allah gave us many things. Allah said in the Quran “And if you should count the favors of Allah you could not enumerate them. Indeed Allah is forgiving and merciful.” Chapter 16, verse 18
Response D	Prophet Muhammad said, “The Prophet said "None of you will have faith till he loves me more than his father, his children and all mankind. “.Bukhari :: Book 1 :: Volume 2 :: Hadith 14
Response E	Ok I will tell you, Hajj teach Muslim that they are brother and equal.

Table 5.12 Different Responses Type in Abdullah CITS

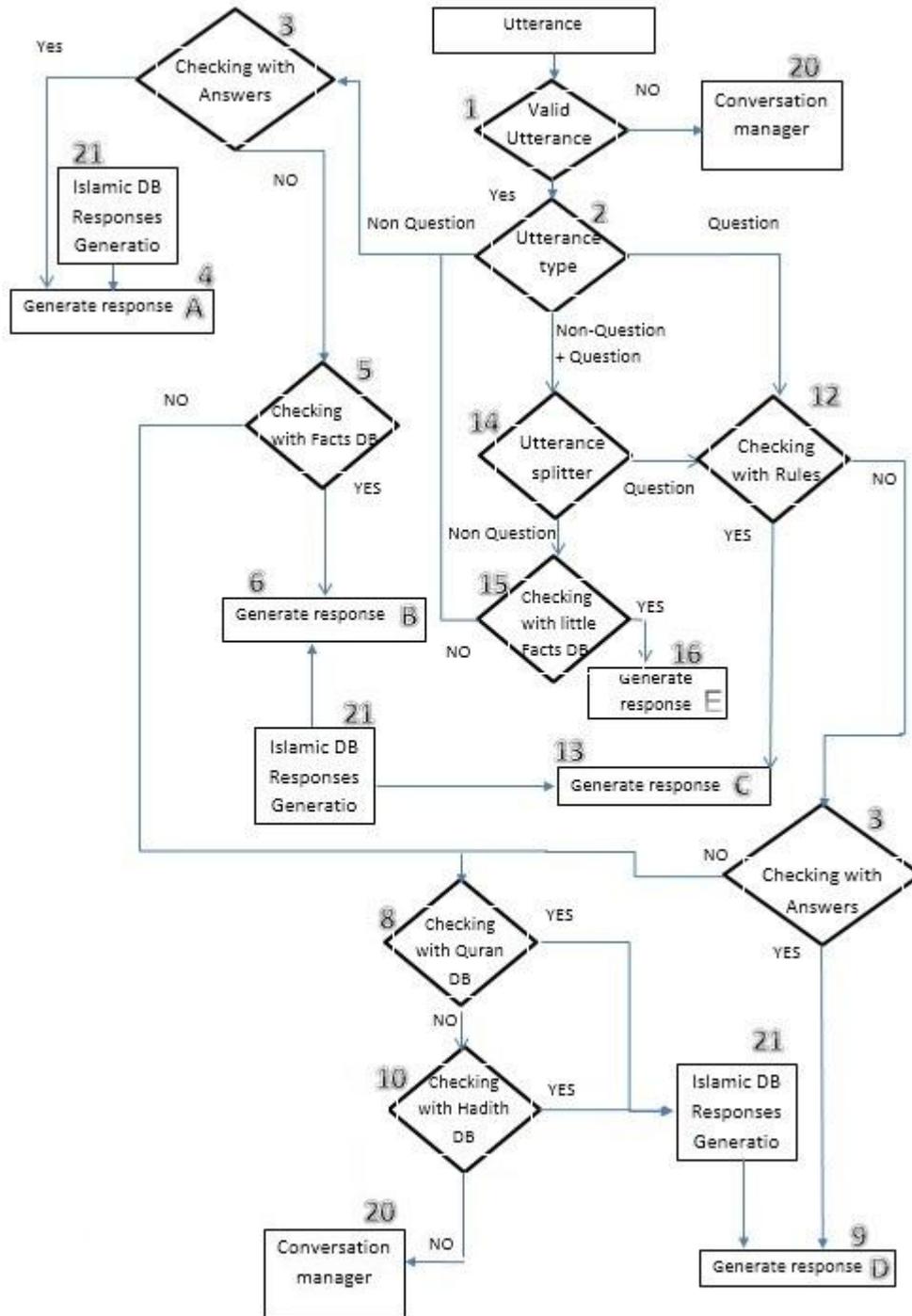


Figure 5.13 Conversation Flowchart

To illustrate the role of the Conversation Manager (CM), managing the flow of the conversation agent consider the following example. The user types in an utterance like “what is the Talbiyyah?” Abdullah CITS will be respond with the following question “Do you know why Hajj is so important to Muslims?” to invoke the user to think about the topic.

The CM will take the user utterance through a number of processes in order to reply in a way that enables the user to think and learn something concerning their question as opposed to simply giving them the answer. The CM will first validate the utterance and removing the punctuation through the utterance validation procedure defined as number 1 in the conversation flowchart (Figure 5.13 Conversation Flowchart). Then the utterance will be checked against the type of the sentences (question, non-question, or question plus non-question sentence), which are defined in the conversation flowchart as number 2. In this example the utterance “what is the Talbiyyah?” is classified as a question belonged to the current topic (since the word (Talbiyyah) are one of the keywords belonged to the subtopic (Hajj)), and starting with one of the exclamatory keyword (what).

After that, the CM will check if there are any matches with the Arabic CA scripts in the knowledge base checking with rules process (number 12). Moreover, in the case, there is no match with the Arabic CA rules, the CM will start to check with other knowledge resources like (Quran, or Hadith).

CM will try to find a match first with the Quran database number eight (checking with Quran), but in this example there are no match with the Quran database.

The CM will move to check with the Hadith database defined as number 10 (checking with Hadith, Figure 5.13). In this example the CM is found the match with the Hadith database (number 10), and then the response will extract from the Islamic response generation database (number 21). This response consists of three parts, which are:

1. The beginning (Prophet Muhammad says,).
2. Prophet Muhammad’s hadith (*“Here I am O Allah! Here I am! Here I am, there is no partner for you, and here I am! Surely, all praise, blessings, and dominion are for you. There is no partner for you”* Hadith Number 256).
3. *Hadith number* according to the Sheh Al-Bakri.

B. Managing tutoring flow

Initially the CITS will start from a random topic (one of three fundamental principles of Islam), the CITS will pick randomly one of the three topics to start the tutorial, which are (to know Your God, to know your prophet, and to know the religion of Islam).

The user will then be led through one subtopic to another until the end of the tutoring session (tutoring flowchart illustrated in section 5.3.1.2.1). The CM will check the flow of the conversation in every iteration and ensure the user stays in the current topic by using leading questions. For example if the conversation is in the context of 'Fasting: the fourth pillar of Islam', the expected path, along with the questions is illustrated in Table 5.13 .

Sub context	Leading Questions
1. Fasting, applies to all Muslims, throughout the world.	<ul style="list-style-type: none"> • Why do we fast in the month of Ramadan?
2. Each day of Ramadan, we should stop eating and drinking between just before sunrise to sunset.	<ul style="list-style-type: none"> • When do we begin fasting? • When do we break fasting?
3. The importance of Ramadan.	<ul style="list-style-type: none"> • What is night of the power? • Is Fasting Healthy?
4. Muslims at the end of Ramadan, celebrating by having a festival known "Eid –al – Fitr".	<ul style="list-style-type: none"> • Which festival occurs at the end of Ramadan?

Table 5.13 a portion from tutoring path

If for example the user is in sub context number 1 and is asked by Abdullah CITS the question, "Why do we fast in the month of Ramadan?". However, instead of the user answer the question the user asks, "What is the night of the power?". The CM is able to recognize that this is a question related to sub context three and it is expected to come later on in the discussion. Thus, the CM will answer the question then rephrase question/rule number three in the path (i.e. what is leytatul Qadar?), and then bring the user back to the original question with a linking question.

This ensures that the learning outcome is achieved by making the user go through all the sub-contexts of the tutorial topic. The user must engage in all tutoring questions to achieve the tutoring goal.

The user utterances will be checked with the stored answers in the knowledge base using the ASTS algorithm (further explanation of this algorithm can be found in section 5.3.2.3). If no match is found the CM matches the utterance to the other sub-contexts in the current tutoring topic and the Quran and Hadith knowledge base. If a match is still not found the CM then check/matches the utterance to the scripts stored in the general context using the PM technique in order to find some relevant information to deliver back to the user. The CM will also apply an appropriate media such as (sounds, pictures, etc.), in order to utilize to make the tutorial session more suitable for teaching students as well as enabling the system to provide intelligent assistance. Subsequent to all these matching efforts, if a match is still not found then a default response of “I do not understand what you mean” is delivered back to the user.

5.3.2.5. The Controller

The controller is firstly responsible for pre-processing and validating the user utterances to ensure the utterances are ready for the matching process. The controller provides a checking/validation process of the user's utterance before proceeding to match against patterns, the utterance should go through an utterance validation process, and the controller will check the utterance for the following:

1. If user send an empty utterance to the system. In this case, the controller considers this as an invalid utterance and a suitable response will be sent back to user. Then if the user continues to enter the same blank utterance for n times ($n=3$), the controller will terminate the session and give the user the reason of termination. The scripter (explained in detail in chapter 7) determines the value of n .

2. The user repeats the same utterance for n times (n=3), the controller will terminate the session and give the user the reason of termination).
3. The utterance contains a rude or inappropriate word, which has been defined in the (facts DB, illustrated in section 5.3.1.5). The controller can determine the level of impolite word, starting from the lowest level L1, L2, L3 each of this level has a value associated with it. Thus, the system will give a different response according to that value and the severity of the language used within the utterance. The controller will give a value of (1) to any words that has been defined in rude word level 1, a value of (2) to any words that have been defined in rude word level 2, and a value of (3) to words that have been defined in rude word level 3. During the conversation session, if the user type in any rude word, which has, been defined in level 1 the system will record a value of 1 in the student's model, and send an appropriate response. However if the user type in the same words defined in rude word level 1, the system will assign a value of 1 and add it to the existing values in the student's model rude values. The session will be terminated if the user acquires or reaches an accumulative value equal to 4 in the student's rude words model (explained in chapter 7).
4. If the utterances contains special characters such as (i.e. ^, |, \, ~, etc.), or it is not in the Arabic language the controller sends a suitable response to user. The controller will apply a number of processes on the utterance, such as to check whether the utterance is written in Arabic language and does not contain special characters.

After the utterance is parsed, the controller then works together with the conversation manager (see section 5.3.2.4) to ensure the conversation is following the correct path. Once this is complete, the controller is responsible for delivering responses back to the user during the tutoring session.

5.3.3. Constructing Abdullah CITS Architecture

This section describes component three, which has been illustrated in Abdullah CITS architecture (Figure 5.3). The final architecture of Abdullah CITS (component three in Figure 5.3), was created by integrating the intelligent tutoring system component together with the Arabic CA. The ITS component contains four individually developed modules, which are:

1. Tutorial Knowledge Base (TKB) (5.3.3.1)
2. The ITS Manager (section 5.3.3.2)
3. Temporal Memory (section 5.3.3.3)
4. The Graphical User Interface (section 5.3.3.4)

The Tutorial KB, ITS manager, and temporal memory will provide the tutoring elements to suit different learners with different knowledge and behaviour, and will be described fully in chapter 7 as these components were developed for the second Abdullah CITS prototype which included adaptation based on the inclusion of learning theories. At this stage of the research, the developed CITS system (Abdullah) will be tested through experiments conducted with end users. However, at this stage the researcher believes that the system will be better tested through Islamic educators. The reason for selecting this group to run the initial evaluation of the system is that this group of individuals have vast experience of delivering Islamic education to the target age group. Their insight will provide essential rigour to the initial testing, as they are experienced in teaching the target age group of Abdullah CITS. Thus, the selected group through their experience can anticipate possible responses and behaviour of children in an Islamic education environment. This will highlight possible weaknesses in the system, which can then be addressed to make the CITS more robust for the target age group.

5.3.3.1. Abdullah CITS Tutorial Knowledge Base (TKB)

The TKB is the second component of the Abdullah CITS knowledge base and it is responsible for managing subject information between learners such as tutorial topics.

Each topic has a number of questions and answers, which have been organized into a goal-oriented structure in order to achieve the goal fulfilment.

The TKB is structured so that the conversation flows, meaning that it has a starting point and a pre-determined finish. The tutorial flow/structure was determined through knowledge engineering techniques that can be found in (section 5.3.1.2). During the conversation there is a specific learning outcome related to each particular tutorial topic. The learning outcome for each Branch achieved by directing the user/student through the conversation by providing questions relating to that topic. The question and answers allow the user to go through the tutorial conversation in order to reach the learning outcome.

In addition, the TKB is structured so that the learner can ask questions related to that topic, these questions are managed through the subtopics that are related and linked to the main tutorial topic. The TKB for Abdullah CITS consists of three main tables as shown in Table 5.14.

Topics		Subtopics		Answers	
PK	TopicsID	PK	TopicsID	PK	AnswerQ_ID
PK	SubTopicsID	PK	SubTopics_ID	PK	SubTopicsID
	SubTopicsQ		SubTopicsQ		AnswerQ_Text
	RuleCount		SubTopic_Text		AnswerQ_1
	ContextID		Context_ID		AnswerQ_2
	Topics_Rule				AnswerQ_3
	Topics_Info				

Table 5.14 Abdullah CITS TKB

- The *topics* table contains all the learning subjects that are covered in the CITS.
- Each *topic* has a number of *subtopics* that are related to the main topic, and stored in the subtopic table.
- The answer table stores the answers for each of the questions, as well as the levels of answers that can be given to the User based on the answer supplied by the user. The answers are organised into three categories based on the user’s Islamic knowledge level (default, low level and advanced). The controller selects the answer that is relayed back to the user.

The domain for this research was concerned about teaching the three fundamental principles of Islam (To know you God, to know your prophet, and to know the religion of Islam), to students aged 10-12 years old, and as an example:

- to know the religion of Islam (main topic)
 - charity (subtopic)
 - 5 prayers (subtopic)
 - Fasting (subtopic)

The tutoring session is complete only when all the questions/rules related to specific subtopics are completed/answered by the user in the tutoring session. For each tutorial subtopic, there is a tutorial for each subtopics, and the user must meet the learning outcome, which is achieved through a number of questions related to the subtopic. The learning outcome is achieved by directing the user towards the goal of the tutorial conversation/topic. The final rule in each sub-topic is considered as the goal of the conversation, and the TKB is structured accordingly. The CM utilises the structured knowledge in the TKB in order to direct the conversation towards the goal through leading the user based on the tutorial question. The user is allowed to ask questions regarding the subtopics; however, the flow of the conversation is directed towards meeting the learning outcome of that topic. In Abdullah CITS, all the tutorial questions are organized in the TKB as questions with answers in a default style. The default questions and their corresponding answers are delivered to the user while the system is trying to determine the users' level of Islamic knowledge. Once the system has gained enough information about the user's level of knowledge, it is able to adapt the questions and the answers within the tutorial session to best match that user's Islamic knowledge (section 5.3.2.4). The low-level knowledge will trigger low-level answers and questions that contain little complexity and are easy to understand as well as provide suitable images and sounds to aid learning. In contrast, high-level knowledge will trigger the high-level questions and answers that contain the more complex concepts and passages from the Quran and Hadith. The TKB will receive information and instructions from the graphical user interface (GUI), and CA via the controller (section 5.3), and will send information back to the GUI and CA via the controller.

5.3.3.2. The ITS Manager

The ITS manager is responsible for determining what Abdullah CITS is to do next at each point during the tutoring session. The ITS manager can interact with the conversation's agent components such as the controller (defined in section 5.3.2.5), the temporal memory (defined in section 5.3.3.3), TKB, and the Graphical user interface (section 5.3.3.4), in order to carry out tutorial activities.

5.3.3.3. Temporal Memory Database

Abdullah CITS will use a temporal memory (Log file) which is stored in a database to record various pieces of information during the conversation. The following information is recorded within the temporal memory database:

1. Each user logged into Abdullah CITS will be assigned with a unique session number that is stored in the log file to identify each user, along with the information related to the tutoring session, which is as follows:
 - a. Utterances from the user – the log file captures every utterance typed by the user during the tutoring session.
 - b. Tutoring topic - the tutoring session is started by Abdullah CITS randomly by selecting a context/topic for the user to go through. Abdullah CITS will then record the sub topics after each utterance delivered by the user.
 - c. Fired rules - during the conversation all the fired rules are captured and stored in the log file. This will help to the system to track the user to see whether the user is following the right path of the tutoring session. However, there are a number of rules that are related to each topic been taught in the tutoring session (will be illustrated in chapter 7). Abdullah CITS will monitor these rules to ensure they are firing in the order of the tutoring session stored in the TKB and direct the user in the case that the user is not following the right order of the rules.
 - d. Time – the time of each conversation and its related utterance are captured and stored in the log file. This data can be used to analysis the level of understanding of the user and for analysis of tutoring success during the evaluation.

2. The utterances entered by the user during the tutoring session are categorised by the controller and stored in the temporal memory as follows:
 - a. Question utterance (an utterance that includes an interrogative word). The CM will handle the questions utterances and match to rules in the CA scripts.
 - b. Statement utterance (an utterance that provides information, or describes something). A statement utterance is an utterance that is not an answer to the current tutoring question (the CM can determine whether the utterances are a response to a question or the user describing some facts or other behaviour). The utterance should not be a verses form the Quran.

The CM will check the statement utterance with the fact table (facts DB, illustrated in section 5.3.1.5). If there is no matching with the fact table, the CM will check with the CA scripts within in the current topic or sub-topics to find an appropriate response.
 - c. Response/answer utterance - Abdullah CITS can tell whether the utterance is an answer to a question related to the tutorial, by checking the utterance against all the stored preferred answers in the Abdullah CITS tutorial knowledge base.
 - d. Quran verse utterance - if the utterance contains only verse or a part of verse from the Quran, the utterance will be classified as a Quran utterance in the log file.
 - e. Hadith utterance - if the utterance contains only a part of a hadith, the utterance will be classified as a hadith utterance in the log file.
 - f. Positive and negative utterance – each utterance is classified either as positive or negative utterances. Abdullah CITS can identify and distinguish between agreement and disagreement within the user utterance.

Based on the classification of the utterance the CM can direct the conversation accordingly (see section 5.3.1.4).

3. However during the tutoring session the answers delivered by the user can be categorized by the CM as follows:

a. The temporal memory can record the answers classification (classify user's answers as either: highly correct, partially correct, or not related answers). The answers classification strategy will ensure that the user are receiving the right level of the tutoring content according to the user's understanding and knowledge in the taught subject.

In addition, the temporal memory will assign a value for the answers that are highly or partially corrected answer and then calculate the average of the user's responses for each subtopic in the tutoring session. The user's answers average will be used later by the CM to direct the conversation by giving an appropriate question back to user according to their level of knowledge, based on the average score as explained in (5.3.2.2.3).

b. Records unsure/unconfident answers from the user, these are the number of times that the user cannot produce an answer with enough confidence (e.g., when user says: "It could be", or "I think" etc.). These types of utterances are matched and classified through the general facts database.

c. Records whether the user utterance is classified as inappropriate and to which level and the offending word is captured and stored (as explained in section 5.3.2.5). This process is conducted when the controller applying the utterance validation. During this process, each word in the utterances will be checked against the list of rude and impolite words (facts DB, illustrated in section 5.3.1.5).

d. Record utterance iteration time, which is the number of times that the system did not get a response from the user within a reasonable time (explained in chapter 6 section 6.5). The time to answer's a question are typically correlated with the difficulty of the question as well as the level of student's knowledge in a particular topics (van der Linden and Xiong, 2013).

The CM will use the recorded time to improve and adapt the tutorial session by selecting an appropriate question type to cope with different learner's level of understanding and ability. For example if the user/learner is able to answer within the appropriate time (see section 5.3.1.2.2 for more detail), this means that this that particular user is displaying a high level of understanding. Alternatively, if the user takes longer than the pre-defined time it means they are struggling. In both cases, the CM is able to utilise this information to adapt the tutoring session accordingly.

5.3.3.4. Graphical User Interface (GUI)

The Graphical User Interface is the interaction point between the user and Abdullah CITS. The GUI manages the communication by receiving the user's utterance through a textbox and posting the utterance's reply back on to the interface. In addition, the GUI displays appropriate media to support the tutorial session, such as photos, sounds, and videos.

This aids the user and provides another dimension to the learning experience, by changing the instructional materials presented to users. The GUI also utilizes a variety of media, such as the background picture, colours, and font type to appeal to different learning modalities as illustrated in Figure 5.14.

The GUI utilises several key techniques of computer-aided learning, which can add more understanding for the user, by allowing the use of learning aids. For example displaying pictures, sounds and related/relevant media to make the topics seem more understandable and keep the user visually and audibly engaged (Cheng et al., 2013). The media is controlled through the scripting language.

The CM checks with the rules in the scripting language for links to relevant media when a rule is fired, for media related to that particular rule which is then displayed to the user according to the type of media associated to that rule (See section 5.3.1.6 for scripting language).

The GUI also uses different colours in order for the user to distinguish between CAL and MSA easier. The output of the GUI uses different colours, which enables the user to easily differentiate between the CAL and MSA.

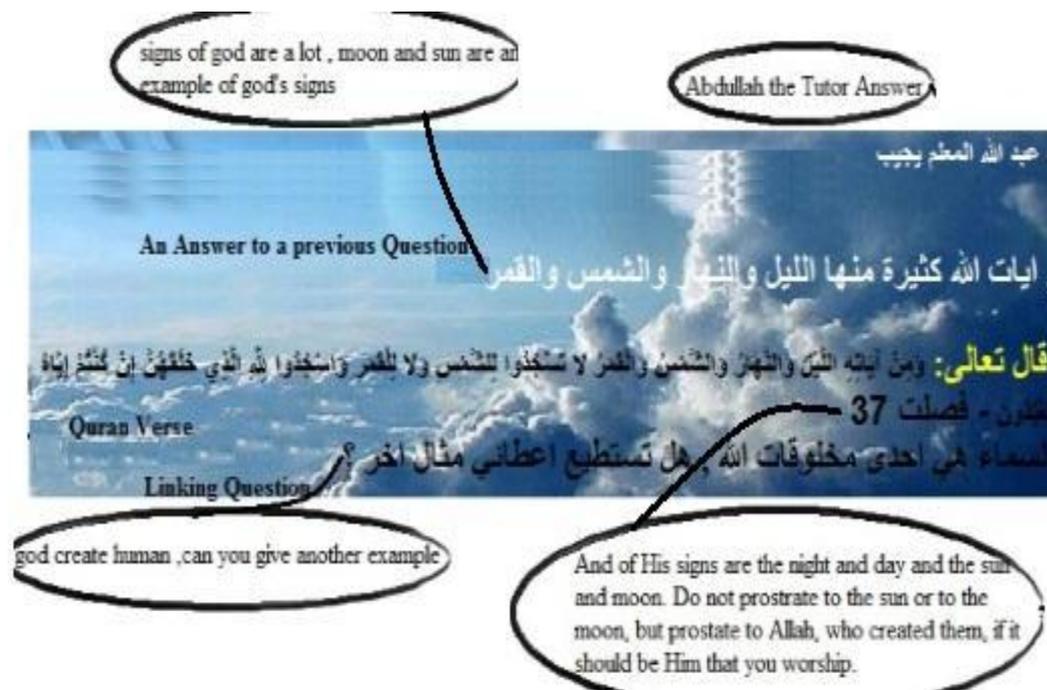


Figure 5.14 Abdullah CITS Screen Shot

5.4. Conclusion

This chapter has outlined a novel conversational intelligent tutoring system called Abdullah that can predict the user's Islamic level of knowledge and adapt the tutoring to suit individual learner's abilities, while directing a tutoring conversation. Abdullah CITS was based on three main components, which are the intelligent tutoring system to provide the teaching contents to students, the Islamic knowledge base which consist of a number of Islamic resources such as the Quran and Hadith, and the conversation agent to direct the tutoring in a conversation method. The methodology for crating Abdullah CITS was based on two phases, which are the creation of Arabic conversation agent, and the construction of the intelligent tutoring system, which come together to form Abdullah CITS. The Arabic CA was designed based upon a number of features specifically suited to the unique challenges of the Arabic language in terms of its morphological nature, and the ambiguity of the Arabic language. The intelligent tutoring system was developed in order to adapt the tutoring content to suit different learner's abilities and knowledge levels. The resulting prototype Abdullah CITS will be used to experimentally validate the methodology and architecture, and will be described in the next chapter.

CHAPTER 6 ARABIC CITS EXPERIMENTS**6.1. Introduction**

The Arabic CITS proposed in chapter 5 teaches users the three fundamental principles of Islam (to know your God, his messenger, and the religion of Islam), whilst directing a tutorial conversation. A prototype of Abdullah CITS was developed to test the methodology and architecture illustrated in chapter 5.

This chapter outlines the experimental methodology of two experiments, which were undertaken to measure the following two hypothesis:

- Abdullah CITS can mimic an Arabic Islamic human tutor.
- Abdullah is an effective Arabic CITS.

In order to measure these hypotheses, a set of subjective and objective metrics had to be defined and justified. The objective metrics are gauged mainly through the log file/temporal memory. A user feedback questionnaire is also used to test the subjective ability. All the subjective and objective metrics captured aim to test hypothesis of the evaluation which relate to the ability of Abdullah CITS in leading the tutorial session, and to check the suitability of the tutoring.

The results of the two experiments demonstrate that Abdullah CITS is successful in its ability to lead the tutoring session. The results also highlight that the majority of the experiment participants expressed that learned from Abdullah CITS, and their level of Islamic knowledge was increased after completing the tutoring session.

6.2. Arabic CITS Evaluation Methodology

The prototype Abdullah CITS is evaluated through two main experiments, designed to gauge different aspects of the developed CITS, which are the tutoring success, and the system robustness. The experiments involved the participants interacting with the system, and are designed in order to gather data related to the tutoring content questions as well as to draw a concrete conclusions related to the hypothesis (which described in section 6.2.1).

All participants selected for these studies were adults whose first language was Arabic and who had previous experience of the three fundamental principles of Islam (but with various levels of expertise) (see section 6.3.2 for further details on participants).

Subsequent to the initial testing and refinements the system can be tested further on the target age group (10-12 years old) at a later stage (in the second prototype of Abdullah CITS, which illustrated in chapter 7), the combination of the two testing stages will ensure the robustness and tutoring success of the final CITS (discussed in detail in chapter 7).

6.2.1. Hypotheses to be tested

The main hypothesis for the experimental studies presented in this chapter are:

- **H1_0:** Abdullah CITS can mimic an Arabic Islamic human tutor.

This hypothesis requires a conversational agent tutor to be scripted to deliver a tutoring session to each student in the same delivery style as a human tutor. The CA is scripted in modern standard Arabic language to handle the user's requests and conversations while the Quran and Hadith were stored in the domain of Abdullah CITS to send the responses in using the classical Arabic language.

In addition a number of Islamic education resources have been utilised to deliver the Islamic topics for year five, such as the book of monotheism for year five in the kingdom of Saudi Arabia (Educational_Development-Saudi_Arabia and 2007, التربوي).

- **H1_1:** Abdullah CITS cannot mimic an Arabic Islamic human tutor.

The conversational intelligent tutoring system and the Islamic topics, which have been selected to deliver the three fundamental principles of Islam for each students, are not possible/suitable to mimic an Arabic Islamic human tutor.

- **H2_0:** Abdullah is an effective Arabic CITS

“Measuring the system effectiveness requires that the system has to meet its specified needs or requirements from a particular viewpoint “ (Smith and Clark, 2006) .

H2_0 also relates to the overall robustness of the system and its ability concerning task completion. The novel Arabic CITS engine, the Arabic scripting language, and methodologies deployed result in an effective functional Arabic CITS.

- **H2_1:** Abdullah is not an effective Arabic CITS

The Arabic CITS engine, the Arabic scripting language, and methodologies deployed result cannot provide an effective Arabic CITS.

6.2.2. Subjective User Evaluation

With the purpose of testing the hypothesis presented in the previous section, a user evaluation feedback questionnaire was designed to gather qualitative user feedback following the Abdullah CITS tutorial.

The feedback questionnaire consists of eight questions to be rated using a five-point scale to express a clearly positive and negative opinion instead of a neutral opinion (Jan Losby, 2012). In addition to these eight questions, the feedback questionnaire also contains four questions requiring a Yes/No answer, one open question, and two questions asking for participants to state two positive and two negative points about using Abdullah CITS, as shown in Table 6.1.

However, these questions are designed to gauge the user's opinion on the usability, and the performance of Abdullah CITS. Similar Questionnaires have been used to gather user feedback on ITS systems to estimate users' subjective feelings of the system and further degrees of satisfaction (Lin et al., 2012).

Please rate these questions and statement using the scale provided	Scale
1. Instructions	High 5 – 4 – 3 – 2 – 1 Low
2. Screen layout and design	High 5 – 4 – 3 – 2 – 1 Low
3. Tutoring	High 5 – 4 – 3 – 2 – 1 Low
4. How well did Abdullah The Tutor understand you?	High 5 – 4 – 3 – 2 – 1 Low
5. Did you find the tutoring helpful?	High 5 – 4 – 3 – 2 – 1 Low
6. Was the conversation natural?	High 5 – 4 – 3 – 2 – 1 Low
7. Was the conversation frustrating?	High 5 – 4 – 3 – 2 – 1 Low
8. Do you feel Abdullah The Tutor helped you to revise?	High 5 – 4 – 3 – 2 – 1 Low
9. Would you use a resource like Abdullah The Tutor: A. Instead of attending a face-to-face tutorial? B. Instead of learning from a book? C. As well as classroom tutoring? D. Would you use the resource at all?	Yes / No Yes / No Yes / No Yes / No
10. What else could Abdullah The Tutor have done to help you learn?	
11. Please state 2 positive points about using Abdullah The Tutor	
12. Please state 2 negative points about using Abdullah The Tutor	

Table 6.1 User Feedback Questionnaire

6.2.3. Objective user evaluation

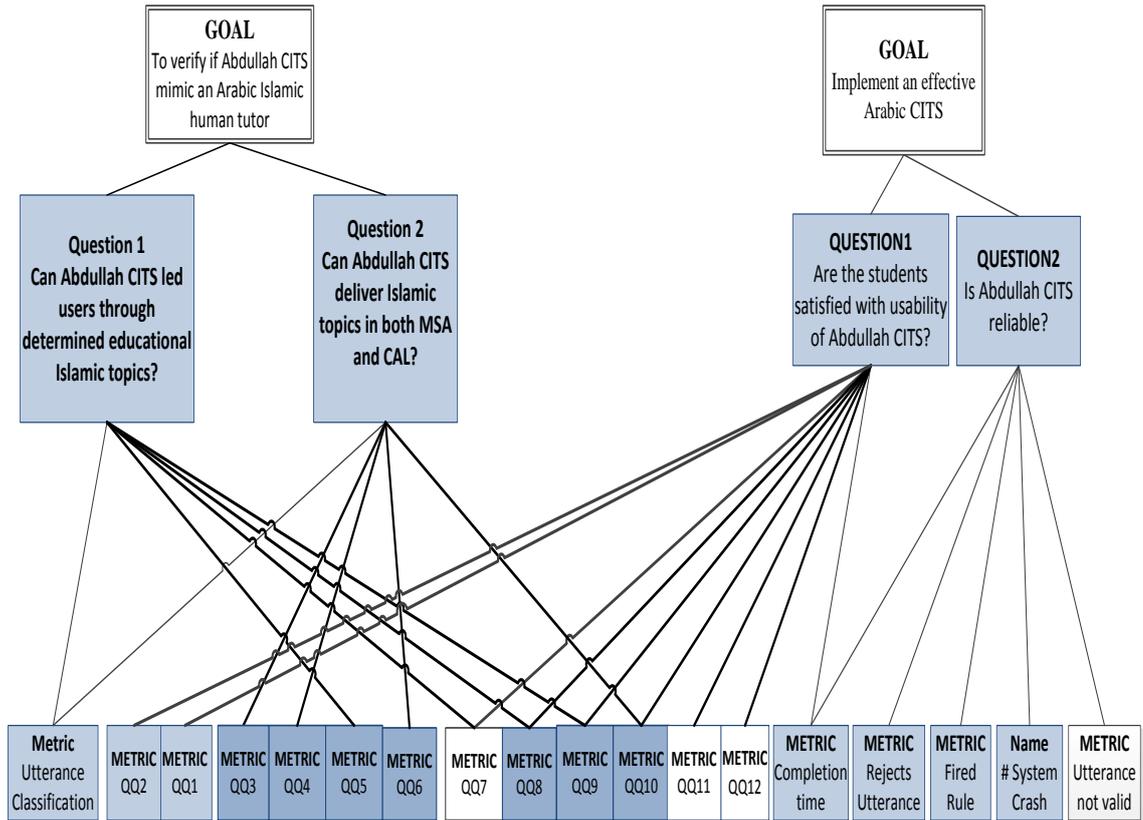
The objective evaluation are concerned about analysing the Abdullah CITS log file, which stores information extracted from the user in the tutoring session. The log file stores a number of variables such as the current topic, the rules that fires during the conversation, and the timing of the tutoring conversation (full variable list can be found in section 5.3.3.3). By using this information from the log file, the data that gathered during the user's interaction with Abdullah CITS was analysed to explore the success of delivering the Islamic contents that suit the level and knowledge of the user.

6.3. Design of Evaluation Metrics

As with any software development, the implementation of the Arabic CITS required a mechanism to measure user feedback and evaluation. One such mechanism is the Goal Question Metric (GQM) approach, which is based on assumption that the goals must be identified first for a system, then for each goal there are a number of questions to define the goal, and finally a set of metrics, associated with every question in order to answer it in a measurable way (Fenton and Pfleeger, 1998).

To test the hypotheses (stated in section 6.2.1), the GQM model will be utilised to formulate which metrics are required to successfully test the hypotheses. Figure 6.1, shows that there are two high level questions that have been defined to test each of the hypotheses (these are shown as two goal questions 1, and question 2 in the GQM model). Each of these hypotheses uses a combination of subjective (questionnaire metrics), and objective metrics (log file metrics).

The objective approach evaluates the Abdullah CITS, by measuring a number of variables captured and stored in the log file created for each individual student during the tutorial. Subjective evaluation uses a questionnaire, which is designed to gather qualitative user feedback following the Abdullah CITS tutorial.



- QQ1 – Questionnaire Question 1 Instructions
- QQ2- Questionnaire Question 2 Screen layout and design
- QQ3- Questionnaire Question 3 Tutoring
- QQ4- Questionnaire Question 4 How well did Abdullah The Tutor understand you?
- QQ5- Questionnaire Question 5 Did you find the tutoring helpful?
- QQ6- Questionnaire Question 6 Was the conversation natural?
- QQ7- Questionnaire Question 7 Was the conversation frustrating?
- QQ8- Questionnaire Question 8 Do you feel Abdullah The Tutor helped you to revise?
- QQ9 Questionnaire Question 9 - Would you use a resource like Abdullah The Tutor:
 - a. Instead of attending a face-to-face tutorial?
 - b. Instead of learning from a book?
 - c. As well as classroom tutoring?
 - d. Would you use the resource at all?
- QQ10 Questionnaire Question 10 - What else could Abdullah The Tutor have done to help you learn?
- QQ11- Questionnaire Question 11 Please state 2 positive points about using the Abdullah The Tutor computer tutor
- QQ12- Questionnaire Question 12 Please state 2 negative points about using the Abdullah The Tutor computer tutor

Figure 6.1 GQM Model for Abdullah CITS Prototype

6.3.1. Experimental Methods for Subjective and Objective Evaluation

To measure the subjective metrics, qualitative user feedback will be gathered by asking the participants to complete a short user evaluation questionnaire (illustrated in section 6.2.2), after completing the Abdullah CITS tutorial. The aim of this questionnaire was to evaluate the learner experiences in using Abdullah CITS, and to assess existing Islamic knowledge.

The objective metrics (illustrated in section 6.2.3), will be evaluated through analysis of the Abdullah CITS log file. The log file used to evaluate, the success of the system and its associated methods in relation to the objective metrics as illustrated in Table 6.3. In addition using the log file will determine whether the information gathered from the user in the tutoring session was indicative of the user's level of knowledge and experienced in the taught subject. The subjective metrics evaluated and their mode of evaluation are summarised and outlined in Table 6.2.

Subjective Metrics		
Metric to be Evaluated	Method of Evaluation	Hypothesis
QQ1. Instructions	Questionnaire	Hypothesis 2
QQ2. Screen layout and design	Questionnaire	Hypothesis 2
QQ3. Tutoring	Questionnaire	Hypothesis 1
QQ4. How well did Abdullah The Tutor	Questionnaire	Hypothesis 1
QQ5. Did you find the tutoring helpful?	Questionnaire	Hypothesis 1
QQ6. Was the conversation natural?	Questionnaire	Hypothesis 1
QQ7. Was the conversation frustrating?	Questionnaire	Hypothesis 1,2
QQ8. Do you feel Abdullah The Tutor helped you to revise?	Questionnaire	Hypothesis 1,2
QQ9. Would you use a resource like Abdullah The Tutor: E. Instead of attending a face-to-face tutorial? F. Instead of learning from a book?	Questionnaire	Hypothesis 1,2
QQ10. What else could Abdullah The Tutor have done to help you learn?	Questionnaire	Hypothesis 1,2
QQ11. Please state 2 positive points about using the Abdullah The Tutor	Questionnaire	Hypothesis 2
QQ12. Please state 2 negative points about using the Abdullah The Tutor	Questionnaire	Hypothesis 2

Table 6.2 Subjective evaluation metrics

OBJECTIVE METRICS		
Metric to be Evaluated	Method of Evaluation	Hypothesis
Utterance classification	Log file	Hypothesis 1
Answers classification	Log file	Hypothesis 1
Fired Rule	Log file	Hypothesis 2
Rejected Utterances	Log file	Hypothesis 2
# System Crash	Log file	Hypothesis 2
Utterances Not Valid	Log file	Hypothesis 2
Completion Time	Log file	Hypothesis 2

Table 6.3 Objective evaluation metrics

6.3.2. Participants

Both of the proposed experiments were undertaken by the same 12 adult participants whose first language was Arabic and who had knowledge of the three basic fundamental principles of Islam (but with various levels of subject knowledge). Four of the participants were active tutors selected from the Almanar Arabic School in Manchester. Five of the participants were selected from Manchester Metropolitan University, all of these participants were from the School and Engineering department in the university. Three of whom were PhD students and two were members of academic staff. The final three participants were retired school teachers. No participants in this study had previous experience using Abdullah CITS. All the participants chosen for this study were selected especially because the initial experiment study will be designed to evaluate the Abdullah CITS from a teacher's point of view.

The initial experimental studies at this stage in development will be done through Islamic religious teachers. The reason for selecting this group to run the initial evaluation of the system was that, this group of individuals have vast experience of delivering Islamic education to the target age group their insight will provide an essential rigour to the initial testing. Thus, the selected group can anticipate possible responses and behaviour of children in an Islamic education environment. This will highlight possible weaknesses in the robustness of the system, which can then be addressed to make the CITS more robust for the target age group.

6.3.3. Participant interaction

Each participants was randomly assigned one of the three main fundamental principles of Islamic religion (To know you God, to know your prophet, and to know your religion of Islam).

Each participants followed a different learning path depending on his or her current knowledge, behaviour and dialogue. As an example, a participant with a low level of knowledge will follow a tutoring path supported with illustrated media (pictures, sound, etc.). While a participant with a high level of knowledge will be assigned the tutoring content with Quran verses or Prophet Muhammad's Hadith. The log file will record the participant's behaviour, such as the type of questions and answers been uttered during the tutoring session.

A URL link was sent to the selected participants along with a set of instructions which detailed how to log in, the task and details of the questionnaires. The login process involved the user entering their name into the system, which was later used to identify each of the conversations. All the twelve participants have to follow the same steps during the tutoring session, which were:

1. The participant logs on to Abdullah CITS by entering the following URL (149.170.120.25/Abdullah/index.jsp).
2. The participant will be assigned randomly one of the three fundamental principles of Islam.
3. Abdullah CITS directed a two-way conversational tutoring session taking an average of 35 minutes to achieve the goal, which is the end of the tutoring session subtopic.
4. Finally, the participants will have to complete a user feedback questionnaire.

6.4. Experiment 1: Abdullah CITS Prototype Tutoring Success

This experiment is conducted to test hypothesis H1 based on the metrics outlined in section 6.2.1. This experiment is based on the log file that records the dialogue between the user and the system.

The participants were selected to engage in a tutoring session, and the participant's knowledge and other behavioural factors (i.e. language used, answers/responses provided to question), were analysed to assess each participant's performance during the tutoring session. The objective and subjective metrics (Figure 6.1 GQM Model for Abdullah CITS Prototype), were used to answer to the two questions related to the first hypothesis (To verify if Abdullah CITS mimic an Arabic Islamic human tutor) which are as follows:

1. **Can Abdullah CITS lead users through determined educational Islamic topics?**
2. **Can Abdullah CITS deliver Islamic topics in both MSA and CAL?**

6.4.1.1. Experiment 1 Results and Discussion (Objective Metrics)

Table 6.4 details an overview of the results gathered from the log file. The results show that during the end user evaluation. Abdullah CITS is able to classify all user utterances that are related to the current context in order to measure the user's level of knowledge/understanding of the tutoring topic.

Users	Number of Utterances	Abdullah CITS Responses Classifications			Goal Achieved
		Advanced	Default	Simple	
User 1:	18	77.8%	22.2%	0.0%	YES
User 2:	17	64.7%	29.4%	5.9%	YES
User 3:	10	40.0%	20.0%	20.0%	NO
User 4:	29	72.4%	6.9%	20.7%	YES
User 5:	36	77.8%	16.7%	5.6%	YES
User 6:	20	65.0%	25.0%	10.0%	YES
User 7:	33	90.9%	9.1%	0.0%	YES
User 8:	26	73.1%	19.2%	7.7%	YES
User 9:	21	52.4%	14.3%	14.3%	NO
User 10:	26	80.8%	15.4%	3.8%	YES
User 11:	32	78.1%	15.6%	6.3%	YES
User 12:	27	81.5%	11.1%	7.4%	YES
Average :	24.58	71.2%	17.1%	8.5%	

Table 6.4 Experiment one Objective Metrics

The results in Table 6.4 also show that Abdullah CITS is able to lead the users in a tutoring session through discussion in order to reach the goal of the tutoring conversation, while delivering the tutoring content and tutoring outcome. From all the conversations during the evaluation, 83.3% (10 users from 12), lead to the goal/learning outcome of the discussion.

In relation to the utterance classification to gauge the user/students level of knowledge the average advanced responses for all the 12 users was 71.2%, 17.1%, for the default responses, and 8.5% are simple responses.

From the results in Table 6.4 it can be seen that during the evaluation the Abdullah CITS classified the vast majority of utterances as 'Advanced', this results was as expected as the participants of the evaluation at this stage were all adults with knowledge about the fundamental principles of Islam.

The objective metrics illustrated in (Table 6.5, and Figure 6.1 GQM Model for Abdullah CITS Prototype), are captured to measure the tutoring success of Abdullah CITS. This is achieved by measuring whether Abdullah CITS can lead the tutorial, recognise the participants behaviour (i.e. utterance classification), and direct the conversation by an appropriate response (answer classification).

Utterance classification	Description
1- Question utterance	User utterance that includes an interrogative word
2- Statement utterance	User utterance that give an information, or describe something
3- Response utterance	Abdullah the tutor can tell whether the utterance is a response to a question related to the tutorial
4- Answers classification	<ul style="list-style-type: none"> • highly corrected • partially corrected • near miss answers
5- Quran verse utterance	verse in Quran
6- Agreement and disagreement utterance	<ul style="list-style-type: none"> • Agreement utterance • Disagreement utterance (have a disagreement word)

Table 6.5 Log File Utterance Classification

The transcript, shown in Figure 6.2, was chosen from the batch of the twelve results to show a sample dialogue of Abdullah CITS. The experiment shows that Abdullah CITS can successfully directing a tutoring conversation by asking the participants to think about the correct subject area rather than simply telling them the answer.

Figure 6.2, shows Abdullah CITS was leading the tutorial so the first sentence was delivered by the CITS asking the participant to enter his/her name. The user was entered Mariam and, the system has recognized the name as a female name and continued to converse with the user (Mariam) in a female conversation style (interaction 3 shows that Abdullah CITS using the word sister for the user Mariam).

The system also picked a random topic to start the tutorial (knowing your prophet Muhammad), and began by asking a provoking question (do you know where the prophet was born). Mariam answered the question by writing the word (Makah). Abdullah CITS dealt with this utterance as a correct answer and gave an encouragement message to the participant (Excellent) then continued into the next question.

<p>1-Abdullah: Welcome to Abdullah the tutor, please write your name</p> <p>2-User: my name is Mariam</p> <p>3-Abdullah: Dear sister Mariam welcome to the program, do you like to converse about the prophet Muhammed? <i>Do you know where he is born?</i></p> <p>4-Mariam: Makah</p> <p>5-Abdullah: excellent, Muhammed (pace be upon him) born in The Year of the Elephant in Makah <i>.What is the secret beyond this name the elephant?</i></p> <p>6-Mariam: Abraha wish to demolish Kaaba</p> <p>7-Abdullah: excellent, Abraha, the ruler of Yemen, marched upon the Kaaba with a large army, which included elephants, intending to demolish it. <i>So does the army demolish the Kaaba?</i></p> <p>8-Mariam: No they can't</p> <p>9-Abdullah: Good, the elephant is said to have stopped at the boundary around Mecca, and refused to enter (Quran: Have you not considered, [O Muhammad], how your Lord dealt with the companions of the elephant, , <i>do you know The First Verse of the Qur'an?</i>)</p> <p>10-Mariam: The Verse of the Al-Fatiha</p> <p>11-Abdullah: I think the right answer is, the Verse of Al-Alaq (Quran: Recite in the name of your Lord who created - (1) Created man from a clinging substance. (2)). <i>do you know how the beginning proselytizing or preaching of Islam was?</i></p> <p>12-Mariam: Secret</p> <p>13-Abdullah: excellent, Muslims worship first years of Islam in a secret way. <i>Do you know where is the prophet going?</i></p> <p>14-Mariam: Kaf, Ha, Ya, 'Ayn, Sad.</p> <p>15-Abdullah: Quran ([This is] a mention of the mercy of your Lord to His servant Zechariah), <i>can you please answer my question (Do you know where is the prophet going?)</i></p> <p>16-Mariam: who's Hinduism?</p> <p>17-Abdullah: Hinduism is the predominant religion of the Indian. <i>Can you please answer my question (Do you know where the prophet is going?)</i></p>	<p>18-Mariam: to al Madina</p> <p>19-Abdullah: excellent, In 622, Muhammad and around 70 Meccan believers left Mecca for sanctuary in al Madina. <i>Do you know what the first battle in Islam was?</i></p> <p>20-Mariam: the battle of Badr</p> <p>21-Abdullah: excellent God bless you, The Battle of Badr was a key battle in the early days of Islam <i>.Do you know what was the second battle in Islam?</i></p> <p>22-Mariam: the Battle of Hunayn</p> <p>23-Abdullah: The Battle of Hunayn was fought between Muhammad and his followers against the Bedouin tribe of Hawazin. <i>can you please answer my question (Do you know what was the second battle in Islam ?)</i></p> <p>24-Mariam: I don't know</p> <p>25-Abdullah: The Battle of Uhud, in 625, Abu Sufyan ibn Harb, King of Mecca. Once again led a Meccan force against Medina. <i>What was the next battle after Uhud?</i></p> <p>26-Mariam: Battle of the Confederates</p> <p>27-Abdullah: excellent God bless you, Battle of the Trench or (Battle of the Confederates) the battle that was Surrounding Medina in 627 , and the results Decisive Muslim victory , During these battles God helps Muslims by angels whose they fight with against non-Muslims. <i>What was the last battle during the prophet period?</i></p> <p>28-Mariam: I don't like angels</p> <p>29-Abdullah: Dear Mariam be careful , God says in Quran (Whoever is an enemy to Allah and His angels and His messengers and Gabriel and Michael - then indeed, Allah is an enemy to the disbelievers.), <i>can you please answer my question (what was the last battle during the prophet period?)</i></p> <p>30-Mariam: Conquest of Mecca</p> <p>31-Abdullah: excellent God bless you, Mecca was conquered by Muslims on 11 December 629 AD</p>
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Figure 6.2 Example Transcript

The participant interaction number and the Log file utterance classification are displayed in Table 6.6. As the tutorial progress, Abdullah CITS continues to recognize the user's utterance and give different levels of encouragement (interaction 9 & 21). In addition, Abdullah CITS also uses supportive material in the session like (chapter 105 verse 1-3, and chapter 96 verse 1-3) from the Quran (interactions 9 and 11). Interaction 14 asks the participant to write a verse from the Quran instead of writing the answer to the previous question (interaction 13). Abdullah CITS has then responded with the next relevant verse from Quran and repeated the same question again (interaction 15). This illustrates the goal –orientation that is built into the system, as a learner must answer a question in the tutorial before progressing. Interaction 16 demonstrates the participant asking a question.

Interaction #	User Input	Utterance classification
2	my name is Mariam	Name is : Mariam M/F : <u>F</u>
4	Makah	Answer
6	Abraha wish to demolish Kaaba	Answer
8	No they can't	Answer
10	The Verse of the Al-Fatiha	Answer
12	Secret	Answer
14	Kaf, Ha, Ya, 'Ayn, Sad.	Quran
16	Who's Hinduism?	Question Not related to Topic
18	to al Madina	Answer
20	the battle of Badr	Answer
22	the Battle of Hunayn	Statement Related to Topic
24	I don't know	Don't know Answer
26	Battle of the Confederates	Answer
28	I don't like angels	Negative Statement
30	Conquest of Mecca	Answer

Table 6.6 Log File Utterance Classification

Abdullah CITS then provides an answer to the question and repeats the previous tutoring question (interaction 17) to keep the participant on the tutoring path. Interaction 22 shows that the participant gets the wrong answer for the previous question, but the participant's answer shows a related fact to the topic (Table 6.6 show that interacts 22 is not an answer, but a related statement to the main topic).

Abdullah CITS sends a declaration response to user and repeats the previous question to give the user another chance to get the right answer. Abdullah CITS can get the utterances that reflect a misunderstanding of facts by the user. Interaction 28 states that the user (Do not like Angels) the system will then send a warning message combined by an appropriate verse from the Quran back to the user (interaction 29).

6.4.1.2. Experiment 1 Results and Discussion (Subjective Metrics)

Table 6.7 shows the user evaluation questionnaire results for the 12 participants. The results show that Abdullah CITS was well received, understandable and helpful. 67% of the participants rated the tutoring highly (rank 4 & 5), and only 16% rated this question low (rank 1 & 2). 83% of the participants found the tutoring helpful (rank 4 & 5), while none of the participants rated this question low (rank 1 & 2). Three quarters (75%) of the participants, felt that Abdullah CITS was helped them to revised, and only a small percentage (8%) rated this question low (both rank 1 & 2).

In addition to that, 83% of the user would use a CITS like Abdullah to support classroom tutoring, 17% stated they would use Abdullah CITS instead of face-to-face teacher. Only 33% of learners agreed that they would use the Abdullah CITS instead of reading a book, and 92% stated they would use the resource in general. These results are illustrated in Table 6.7.

Questioners	High 5	4	3	2	1 Low
1. Tutoring	42%	25%	17%	8%	8%
2. Did you find the tutoring helpful?	50%	33%	17%	0%	0%
3. Do you feel Abdullah The Tutor helped you to revise?	33%	42%	17%	8%	0%
4. Would you use a resource like Abdullah The Tutor:	Yes				No
Instead of attending a face-to-face tutorial?	17%				83%
Instead of learning from a book?	33%				67%
As well as classroom tutoring?	83%				17%
Would you use the resource at all?	92%				8%

Table 6.7 Experiment 1 - User Feedback Questionnaire's Results

6.5. Experiment 2: Abdullah CITS Prototype System Robustness

This experiment was conducted to test hypothesis H2 and will be gauged on the metrics outlined in 6.2.1, and Table 6.2. The intention behind this experiment is to measure the effectiveness and robustness of the Abdullah CITS. System robustness (Figure 6.1) will be measured after all 12 users finish their tutoring session by analysing a number of variables in the log file, such as the fired rule, the rejected utterance, and the timing for each interaction during the conversation. These variables were recorded in a log file. The robustness relates to the system's ability to produce correct responses to user questions and the degree of accuracy of the rules fired. Furthermore, robustness indicates how well the system performs in the real world with real users. The average time for an utterance in a dialogue (ATPU), will be calculated using Equation 9. This equation will calculate the average time for all utterances in all dialogues (for the 12 participants), by dividing the total duration for all dialogues by the total utterances in the whole dialogues.

$$\text{ATPU} = \frac{\text{Total durations for all dialogues}}{\text{Number of utterances for all dialogues}} = 67.16$$

Equation 9 Average Time for Utterance (ATPU)

Then the average time per interaction for each dialogue (ATPI), will be calculated using the following equation:

$$\text{ATPI} = \frac{\text{Participant's time per interaction}}{67.16} * 100$$

Equation 10 Average Time per Interaction

Equation 10 calculate the average time per interaction for the dialogue, by dividing the participant's time per interaction by the average obtained from Equation 9. However, Abdullah CITS can predicts when the user are satisfied with the system found no difficulty in a conversation session, when the participant's ATPI is around (67.16). Moreover, in the case the participant's ATPI less than (67.16), Abdullah CITS predicted that the user is misunderstanding to the system and finds a difficulty during the conversation session.

6.5.1. Experiment 2 Results and Discussion (Objective Metrics)

The robustness of the Abdullah CITS will be examined after all participants have finished the tutoring session. During the tutoring session, a number of variables were recorded in the log file, such as the matched rules, rules that has belonged to the current context, user behaviour, and the time per interaction (see section 6.3.1 for the all the variables recorded in the log file).

The number of matched rules represents the ability of Abdullah CITS to continue the conversation even if it does not understand some of the information given by the user.

For example, in dialogue 11 in (Table 6.8, and Dialogue 1 in Appendix 2: Tutoring Dialogue (Translated Version)), the Arabic CA has a match of 96.88% to the user utterance. These findings from dialogue 11, and other dialogues (i.e. Dialogues 2,4,7,8, and 12), that illustrated in Table 6.8 represent how well the system understood the user, and direct the user in the correct path.

Dialogue two and six in Table 6.8, shows that the system has the ability to understand and prevent unrealistic expectations of the system, by a matching of 95% in a rule that belongs to the current context during the conversation in dialogue 6. The Arabic CA has the ability to put the user back on the right track again during the conversation even if the user is starting to converse outside of the domain rang. However, Table 6.8 shows that most of the dialogues have an ATPI above the average (67.16), except for dialogues 7, 10, 11, and 12.

In addition, the experiments results shows that very few dialogues contained rude/inappropriate words with a highest value of 7.69% in dialogue 8, as illustrated in the Table 6.8 and appendix 2. One further thing that can improve the robustness of the system is better methods for handling errors, invalid utterances, and the behaviour of the user during the conversation. Such improvements progress the overall robustness and intelligence of the system, because users do not always behave as expected or predicted.

A more robust system should always have the ability to direct such users in the right direction and ensure the learning outcome is achieved. From the experiments and evaluation results, it can be concluded that the experimental results described in this section successfully validate the robustness of the Abdullah CITS.

	Number of Utterances	Rules Belonged			Time per Interaction
		Matched Rule	to Current Context	Inappropriate Words	
Dialogue 1:	18	85.71%	92.86%	-	90.74%
Dialogue 2:	17	94.44%	94.44%	-	96.70%
Dialogue 3:	10	70.00%	90.00%	-	95.92%
Dialogue 4:	29	93.10%	86.21%	-	90.52%
Dialogue 5:	36	80.56%	88.89%	-	80.66%
Dialogue 6:	20	90.00%	95.00%	-	85.02%
Dialogue 7:	33	93.94%	87.88%	-	46.58%
Dialogue 8:	26	96.15%	76.92%	7.69%	96.77%
Dialogue 9:	21	71.43%	76.19%	-	94.82%
Dialogue 10:	26	69.23%	76.92%	-	66.20%
Dialogue 11:	32	96.88%	65.63%	3.13%	54.64%
Dialogue 12:	27	92.59%	74.07%	3.70%	62.15%

Table 6.8 Results for Participants Used Abdullah CITS

6.5.2. Experiment 2 Results and Discussion (Subjective Metrics)

Table 6.9 shows that 67% of participants rated the instructions provided by Abdullah CITS highly, with 25% awarding the instructions the highest rating (5). None of the participants rated this question low. In question 2 the screen layout and design, 83% of the participants rated this question highly with 33% awarding this question the highest rating of 5 and half of the participants awarding this question the rate 4. However none of the participants awarding this portion of questionnaire low (Table 6.9). The results also shows that 75% of the participants found that Abdullah CITS understands what they type in the tutoring session (question 3). In Question four, 83% of participants rated the Abdullah CITS tutoring conversation as natural. However in Question five, 84% of participants found the conversation frustrating. Question 5's result may reflect the undefined nature of the question, as participants may have been frustrated by their failure to answer questions or remember the main topic.

	High 5	4	3	2	1 Low
1. Instructions	25%	42%	17%	17%	0%
2. Screen layout and design	33%	50%	17%	0%	0%
3. How well did Abdullah The Tutor understand you?	17%	25%	33%	25%	0%
4. Was the conversation natural?	25%	25%	33%	17%	0%
5. Was the conversation frustrating?	17%	25%	42%	17%	0%

Table 6.9 Experiment 2 - User Feedback Questionnaire's Results

The last three questions from the user feedback questionnaire were open questions, asking the users what else Abdullah the tutor can do to help you learn. In addition to that, a three positive and three negative open questions were been asked in the open questions to state about using Abdullah CITS. The answers for each question were counted along with the percentage of users who is targeting these answers as shown in Table 6.10.

User open feedback questionnaire shows that 83.3% of the users found that Abdullah CITS was using supportive Islamic resources like (Quran and Hadith) during the tutoring session (question 11 in Table 6.10), as well as user positive question (question 11). 33.3 % of respondents found that Abdullah CITS are helpful, 25% of respondent is declared that Abdullah CITS was easy to the user, and 8.3 % found that the CITS are enjoyable.

When the participant were asked to provide negative comments (question 12 in Table 6.10), 41.6 % found that the user interface had some difficulties in presenting Abdullah the tutor to the user. 33.33% respondents noted that Abdullah CITS did not always understand the user input and 33.33% found the tutoring questions sometimes have some Arabic grammar problems.

Open Questions	Users answers (or equivalent)	Number of user	Percentage
10. What else could Abdullah The Tutor have done to help you learn?	• Using supportive Islamic resources (Quran, and Hadith), within responses.	8 out of 12	66.66%
	• Nothing	3 out of 12	25%
	• Empty	1 out of 12	8.33%
11. Please state 2 positive points about using the Abdullah The Tutor	• Using Islamic resources like (Quran verses, Hadith, and Tafsir).	10 out of 12	83.33 %
	• Helpful	4 out of 12	33.33 %
	• Abdullah the tutor was easy to use.	3 out of 12	25 %
	• Enjoyable	1 out of 12	8.33 %
12. Please state 2 negative points about using the Abdullah The Tutor	• User interface	5 out of 12	41.66 %
	• Abdullah the tutor does not always understand the utterances.	4 out of 12	33.33 %
	• Arabic grammar	4 out of 12	33.33 %
	• Empty	2 out of 12	16.66 %

Table 6.10 User Feedback- Open Question Summary Analysis

6.6. Experiments Conclusion

In the evaluation of Abdullah CITS, twelve users with 292 utterances were accessed Abdullah CITS, the average number of utterances per user was 24 utterances. The two experiments were designed to test the hypotheses described in section (6.2.1), by testing/answering a number of questions associated with each hypothesis.

The GQM approach illustrated in (6.3), defines a certain goals/hypothesis, refines this goal into questions, and defines metrics that should provide/answer these questions. By answering the questions, the measured data explains the goals operationally and can be analysed to identify whether or not the goals are achieved. The two hypotheses along with the questions are described as follows:

1. Hypotheses 1: Abdullah CITS can mimic an Arabic Islamic human tutor.

This hypothesis is required an Arabic CA component who is scripted to handle the modern standard Arabic language. There are two questions were assigned to test these hypotheses, which are:

- I. Can Abdullah CITS led users through determined educational Islamic topics?
- II. Can Abdullah CITS deliver Islamic topics in both MSA and CAL?

2. Hypotheses 2: Abdullah is an effective Arabic CITS

This hypothesis will test the novel engine, Arabic scripting language, and the methodologies deployed result in an effective functional Arabic CITS.

Two questions were assigned to test this hypothesis, which are:

- I. Are the students satisfied with usability of Abdullah CITS?
- II. Is Abdullah CITS reliable?

The experimental results showed that Abdullah CITS could direct the students in the tutoring session by engaging the students in a conversation dialogue. Therefore, the first hypothesis (To verify if Abdullah CITS mimic an Arabic Islamic human tutor) is supported.

The results also demonstrate that Abdullah CITS is achieving the goal for delivering the three fundamental principles of Islam using both modern and classical Arabic language, thus, the second hypothesis are also supported.

6.7. Conclusion

The experimental studies that are described in this chapter successfully validate the ability of Abdullah CITS to lead a tutoring session, directing the students based on their behaviour. The majority of the participants who were involved with the evaluation of Abdullah CITS, state that Abdullah CITS is a helpful system and enjoyable, particularly with relation to the use of many media (i.e. pictures, and sounds), to support the learning. The end user evaluation also highlighted area that need to be strengthened through further research and development. Firstly, further research and development is required into techniques and methodologies, so that the Abdullah CITS can cope with target user age group comprising of 10 to 12 years old, as up until this point of the research the goal was to develop an appropriate architecture.

Now that the architecture has been validated through the end user evaluation, the research will now focus on adding to the general architecture to make it suitable for the target age group. This will entail extensive research into pedagogical learning theories and how these can be implemented into Abdullah CITS in order to make the learning process more effective.

Furthermore, with relation to making the CITS more suitable for the target age group further research and development of the knowledge base will be required to enhance the existing knowledge base to make it suitable for the younger target age group. Through the end user evaluation, it has been discovered through user feedback that the tutoring delivered by Abdullah CITS is linear and rigid, meaning that all the users are delivered the same tutoring style/theory regardless of their ability and level of subject knowledge. A real world tutor is able to adapt to the different students abilities in order to tailor the tutoring style to suit the particular student's abilities, which maximise learning gain. In order for Abdullah CITS to successfully mimic a human tutor this feature is important. In order to address this and make the tutoring more adaptable further research into CITS will be conducted in order for the Abdullah CITS to capture and gauge the user/students level of knowledge and adapt the tutoring content delivered to suit the individual/different levels of student's abilities and knowledge.

Lastly, certain weaknesses related to Abdullah's CITS short text similarity measure were found during the end user evaluation. The STS measure is restricted to work with a limited Islamic knowledge base, which contains the Quran and Hadith only. However, the Islamic knowledge base will be extended by implementing an additional resources (i.e. Tafsir). The STS measure will be enhanced in order to work with these updated Islamic knowledge base so that Abdullah CITS is able to formulate better responses to user questions.

Subsequent to the further research and development, the update architecture will be evaluated once again, however this time the CITS will be evaluated with participants of the target age group. This will involve deploying the CITS application with a classroom environment to allow the students to interact with the system. The subjective and objective data gathered from the evaluation will then be statistically analysed in order to validate the additional components and improvements made to the architecture of Abdullah CITS.

The next chapter outline all the further research and development undertaken to address these weakness and further strengthen the Abdullah CITS.

CHAPTER 7 ARCHITECTURE AND METHODOLOGY FOR DEVELOPING AN ARABIC CITS TO ASSIST STUDENTS: REVIEW OF STUDENTS

7.1. Introduction

It has been established that, Conversational ITS (CITS) are not widely used in the field of ITS, and to the authors knowledge there is no current research in the development of a CITS that can handle both modern and classical Arabic language. In chapter 5, an architecture was proposed to develop an Arabic CITS, known as Abdullah. This Arabic CITS was designed to mimic an Arabic Islamic tutor that can teach Islamic topics in both modern and classical Arabic language. This chapter aims to outline the further developments and enhancements made to the Abdullah CITS.

Based on the findings from the first evaluation (Chapter 6), there were a number of areas highlighted where the components of the Abdullah CITS could be improved (see section 6.7). As well as addressing the weaknesses in the first prototype system this section also details the research and development carried out in order to make the system suitable for the target age group (10-12 years old).

In order to adapt the CITS architecture an extensive research into learning theories and methods was undertaken, and how these theories could be effectively implemented into a CITS with the intention of teaching children aged (10-12) the principles of Islam.

Therefore, this chapter proposes a methodology and architecture for creating an Arabic Teaching Assistant Conversational Intelligent Tutoring System called Abdullah ATA-CITS. The original methodology and architecture introduced in chapter 5 are adapted to include different learning theories and methods suitable for teaching children aged 10-12 years old. The learning theories and method are selected to deliver suitable teaching for individual learners during the tutoring session.

With the newly developed architecture components, Abdullah ATA-CITS is able to determine the user/learners level of Islamic knowledge by analysing the user's utterances during the tutorial and to adapt/adjust the tutoring session to suit the individual user/learners abilities.

Learning methods such as storytelling, and concepts derived from Gagne and Piaget learning theories, are implemented in Abdullah ATA-CITS to suit that user's level of knowledge specifically to targeting young learners.

7.2. Methodology for Creating an Arabic CITS Teaching Assistant

The Arabic teaching assistant conversational intelligent tutoring system (Abdullah ATA-CITS) is developed by extending the architecture proposed and implemented in chapter 5. Abdullah ATA-CITS incorporates the learning theories into existing Abdullah CITS architecture (described in section 5.2).

In addition to the learning theories the Islamic database, short text similarity, and the scripting language were all modified to suit the age group of the user (10-12 years old).

7.3. The Teaching Assistant Abdullah CITS Architecture

Abdullah ATA-CITS is an extension of the Abdullah CITS architecture illustrated in (section 5.3). The adapted Abdullah ATA-CITS architecture consists of all the components, which were implemented in Abdullah CITS, and the new developed components (i.e. learning theories, CA scripts etc.) which come together to form the new architecture of Abdullah ATA-CITS as illustrated in Figure 7.1.

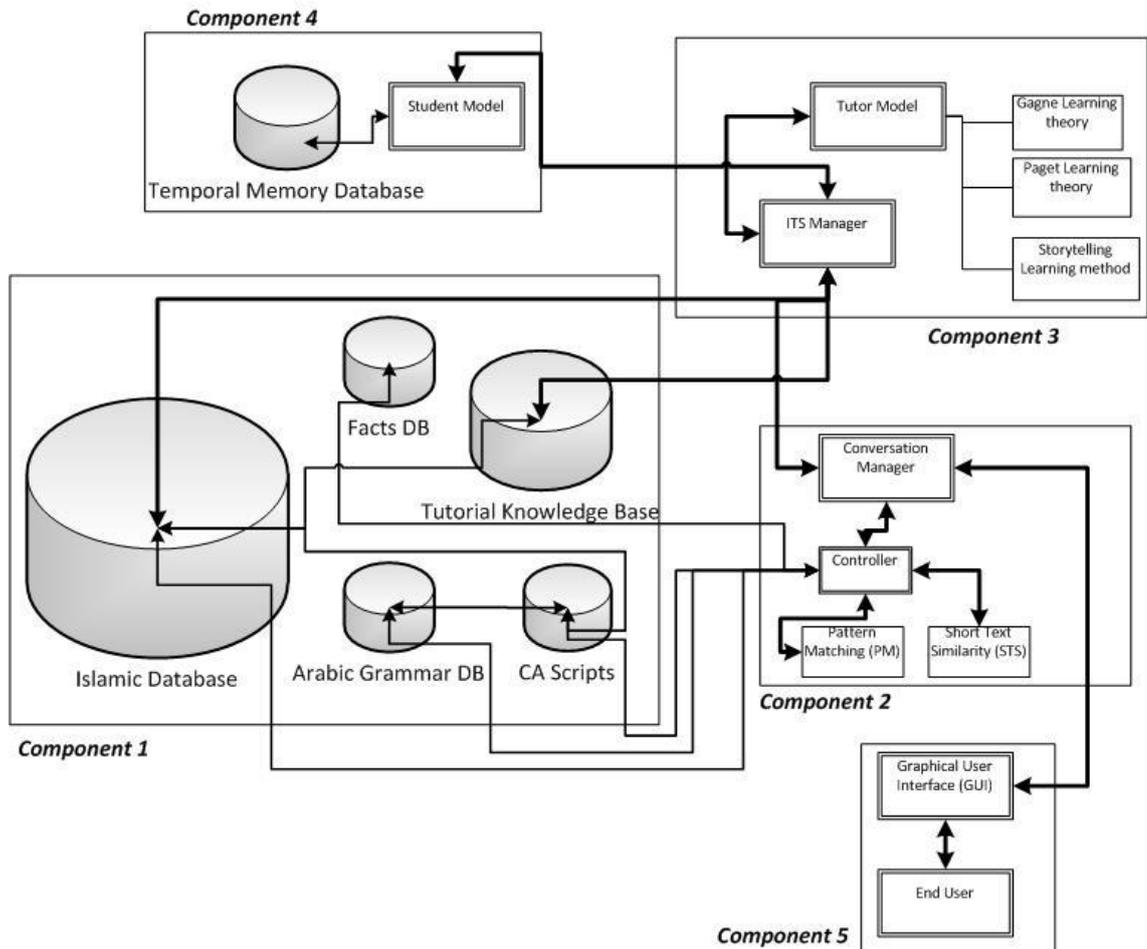


Figure 7.1 Abdullah ATA-CITS Architecture

Figure 7.1 shows that the architecture of Abdullah ATA-CITS consists of five main components; each of these components contains a number of modules, described as follows:

Component 1: is considered as the brain of Abdullah ATA-CITS, and is made up of three databases, a knowledge base, and CA scripts, which can be summarised as follows:

1. Islamic Database (IDB)
2. Arabic Grammar Database (AGDB)
3. Facts Database (FDB)
4. Tutorial Knowledge Base (TKB)
5. CA scripts

AGDB, FDB, and TKB are remain unchanged. While IDB, and CA scripts were modified in Abdullah ATA-CITS (see sections 7.3.1.1 and 7.3.2 respectively).

Component 2: is considered as the first part of the Abdullah ATA-CITS engine. Four modules make up component two which are:

1. The conversation manager (CM)
2. The controller
3. Pattern matching (PM)
4. Short text similarity (STS)

The controller and PM are remain unchanged. While STS and CM were modified in Abdullah ATA-CITS (see sections 7.3.3.5 and 7.3.3.6 respectively).

Component 3: which is the second part of the Abdullah ATA-CITS engine, and it refers to the ITS part of Abdullah ATA-CITS. This component contains the newly developed ITS models and the learning theories, as summarised below:

1. ITS manager
2. Tutor model
3. Gagne learning theory
4. Paget learning theory
5. Storytelling learning method

The ITS manager is remain unchanged. While the Gagne learning theory, Paget learning theory, and storytelling learning method were all implemented in the tutor model as described in (section 7.3.4.2).

Component 4: this component is used to record the user's behaviour during the tutoring session, and has two main modules, which are:

1. The student model, described in (section 7.3.4.1).
2. Temporal memory (log file), described in (section 7.3.4.1.1).

Component 5: the user interface component is the last component in Abdullah ATA-CITS architecture and is used to handle the follow:

1. The graphical user interface, described in (section 7.3.4.3).
2. The end user input and CITS output (utterance and response).

Each of these modified modules, in the architecture of Abdullah ATA-CITS will be explained further in the following sections of chapter 7.

7.3.1. Abdullah's ATA-CITS Domain

The domain of Abdullah ATA-CITS consists of three main databases, as mentioned in component 1, which are Islamic database (IDB), Arabic grammar database (AGDB), and Facts database (FDB). In addition to these databases, the domain of Abdullah ATA-CITS contains a CA scripting language, as well as Tutorial knowledge base (TKB) as shown in (Figure 7.1 Abdullah ATA-CITS Architecture).

These three databases (IDB, AGDB, and FDB) are considered as the brain of Abdullah ATA-CITS, and it contains a number of related tables, which forms the knowledge/brain of Abdullah ATA-CITS (illustrated in Figure 7.2). The architecture of the Abdullah ATA-CITS contained the databases described in (chapter 5 section 5.3.1.3), in addition new tables were added to Islamic database. These tables were the Tafsir table, Muslim scholar table, and the noble woman around the messenger table.

However, the primary aim of development of the Abdullah ATA-CITS knowledge domain is to ensure the new developed system can cope with the target age group of students (10-12).

In addition to the age group, the gender of the students was also taken in consideration by presenting appropriate Islamic sources of information (i.e. Muslim scholar table for the male students, and noblewoman around the messenger tables for female students).

Each of these developed databases of Abdullah ATA-CITS with its additional fields will be discussed in the next section.

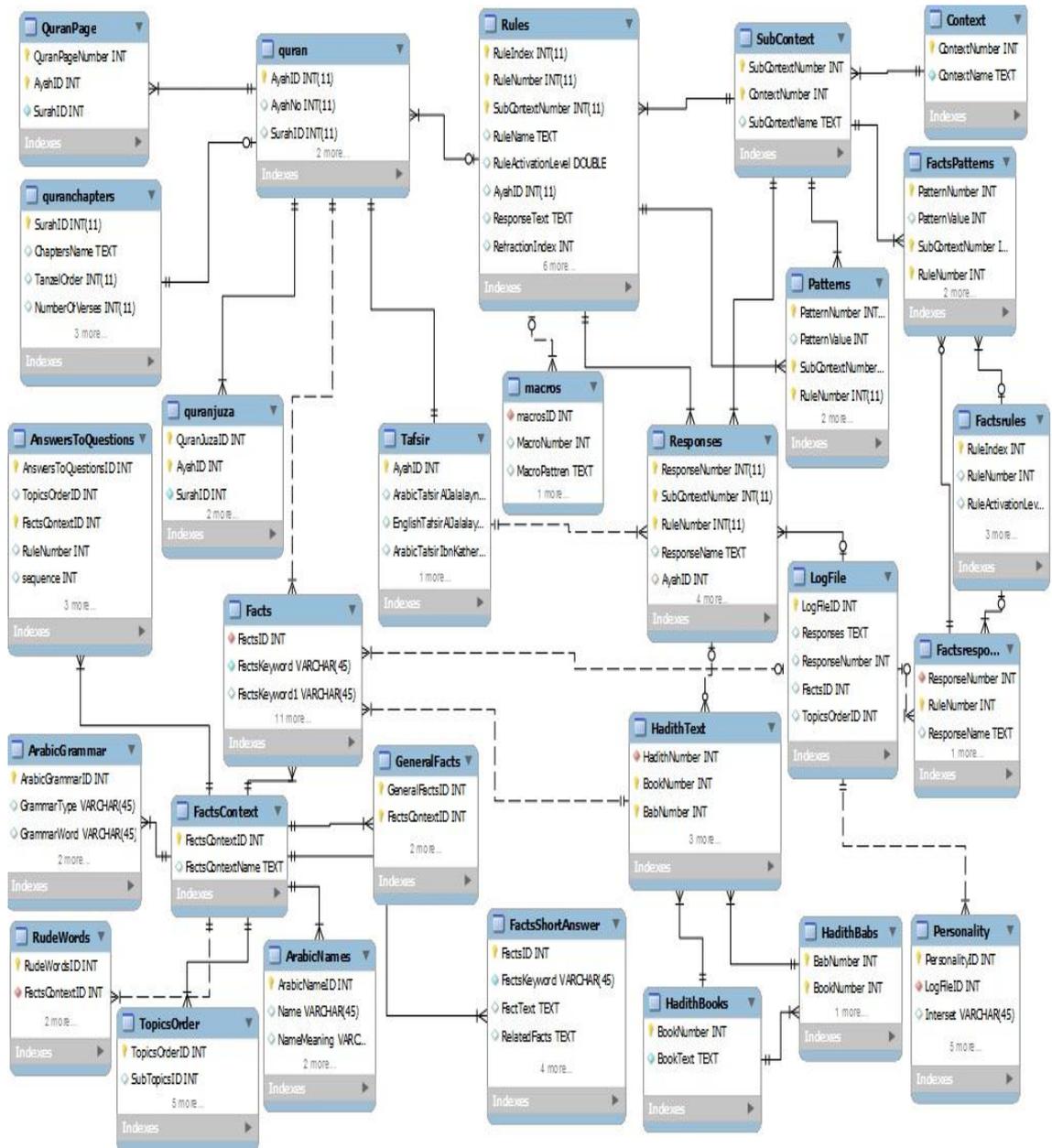


Figure 7.2 Abdullah ATA-CITS Domain

7.3.1.1. Modifications to the Islamic Database

The Islamic database plays an important role in Abdullah ATA-CITS domain, as it is considered the source for all the tutoring content delivered to the students during the Sub tutoring session. It has been discussed in chapter five (5.3.1.3), that the Quran and Hadith are the main two resources for Islamic database.

Both of these sources are indispensable, one cannot practice or teach Islam without consulting both of them (Al-Albani, 1980).

Abdullah ATA-CITS implemented two additional Islamic resources in the Islamic database, which are the Tafsir (Quran explanation), and the Muslim Scholar tables. The Tafsir (Quran explanation), can help to properly explain and contextualise the revelation of the Quran (Muthmainnah, 2000). Since the Quran has been revealed to the Prophet Muhammad in classical Arabic language, modern day Muslims are seeking to gain a better understanding of their own faith, by using such a resource like Tafsir.

The Quran Tafsir is a vast knowledge base, which is used to explain clarify, and interpret the holy Quran. The Tafsir books are read by Muslims in order to gain a better understanding of the Quran narrative, laws, and meanings are written by world renowned and respected Islamic scholars of the early Islamic time such Ibn Kathir (Kathir, 1990) .

In relation to teaching the Quran and Islamic topics to the target age group (10-12 years old), it is very important to know the meanings and correct interpretations of the topics. Typically not understanding the context and meaning leads to misrepresentation and wrong understandings of the topics, which is completely forbidden in Islam. As an example Figure 7.3 illustrate the translation of chapter 100 (Al-Adiyat) from the Quran. The name of this chapter translates to “the running”, using Tafsir it is clarified what the running is related/refereeing to. (Kathir, 1990, Maududi, 1965), who are a respect Tafsir scholars, states that this running is related to the running of horses.

According to Ibn Kathir and Maududi, they translated/interpreted the chapter name like this, because “There is no indication in the words of the chapter to show whether “those who run” imply the horses or otherwise; because only the word Al-Adiyat (by, those who run) has been used. That is why the commentators have disputed as to what is implied by “those who run”.(Maududi, 1965).

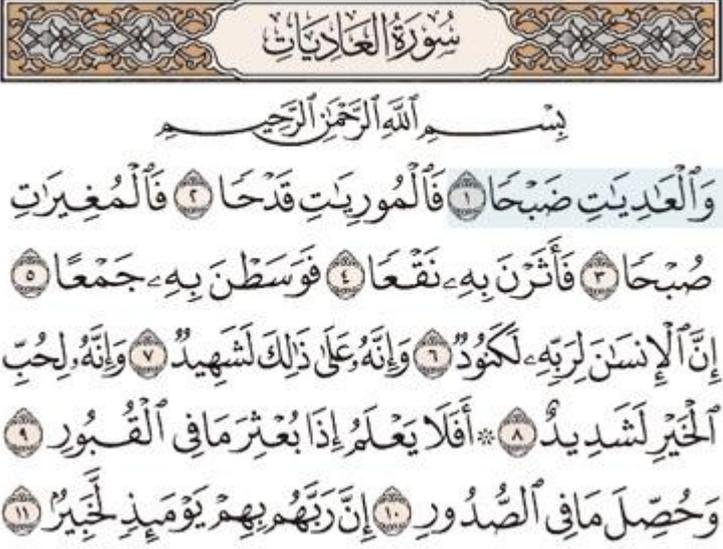
Arabic Quran Script	English: Saheeh international
	<p>By the racers, panting, (1) And the producers of sparks [when] striking (2) And the chargers at dawn, (3) Stirring up thereby [clouds of] dust, (4) Arriving thereby in the centre collectively, (5) Indeed mankind, to his Lord, is ungrateful. (6) And indeed, he is to that a witness. (7) And indeed he is, in love of wealth, intense. (8) But does he not know that when the contents of the graves are scattered (9)</p>

Figure 7.3 Quran Script with English Translation

The Muslim Scholars table (MST) (Khālid, 2007), and the noble women around the messenger table (NWT) (Al-Jada and Hassan, 1998), has been added to the Islamic database. These two tables contains two corresponding fields, which are the scholar name, and a brief short story about each of these scholars, as, illustrated in Table 7.1.

Through the implementation of these tables into Islamic database, the users will have the opportunity to learn more about the first generation of Muslims. The user will be able to learn about men of that period with the Prophet Muhammad (PBUH) through relevant stories related to the tutoring topic (Khālid, 2007).

By implementing the MST, and NWT tables into the Islamic Database a number of learning lessons can be achieved such as to identify the key character in faith story (i.e. the story of Bilal Ibn Rabah mentioned in Table 7.1), as well as to acquire/gain a big ideas about the story (i.e. slavery and freedom, God and prayer) (Moss, 2011).

Scholar Name	Scholar's Short Story
Bilal Ibn Rabah	Whenever Umar Ibn Al khattaab mentioned Abu Bakr he would say, "Abu Bakr is our master and the Emancipator of our master." Bilal. Bilal was among the emancipated slaves freed by Abu Bakr due to the Islamic teachings of slavery. He was known for his beautiful voice with which he called people to their prayers.
Suhaib Ibn Sinaan	He was born surrounded by comfort and luxury. One day the Romans who captured a large number and enslaved the boy Suhaib Ibn Sinaan attacked the country. When Muhammad gave permission for his followers to migrate to Medina in 622, Quraish discovered Suhaib intentions and placed guards over him to prevent him from leaving Mecca and taking the wealth he had acquired through trade. Suhaib agreed to leave all his wealth, and migrate to Almadena. When Suhaib came into view, the Prophet (PBUH) was sitting surrounded by his Companions. As soon as the Prophet (PBUH) saw him, he called to him cheerfully, "O Abu Yahia! A profitable sale! A profitable Sale!"

Table 7.1 A bunch of Prophet Muhammad's companions

However, these additional tables (MST, and NWT), contain knowledge which is considered a very important in the learning topics of the Abdullah ATA-CITS as it provide the facts about the prophet Muhammad's companions (Sahabah) and related people to the learning content. The companions are the individuals who had met or had seen Prophet Muhammad during the time when he was alive. These individuals are those who preserved and delivered the message of the Prophet Muhammad to every corner of the known world at that time (Dank, 2009).

Table 7.2 illustrates a portion of the conversation between Abdullah ATA-CITS and the user Mariam. Abdullah ATA-CITS is using the storytelling method (described in section 7.3.4.2.3) to explain and illustrate the tutoring topic (To believe in God) to the user (Mariam). The story has been extracted from the Islamic database (i.e. NWT), to suit the current tutoring topic as well as the gender of the user as illustrated in the following table.

<p>عبد الله يجيب : الايمان بالله , هو ان تعبد الله كأنك تراه , فإن لم تكن تراه فهو يراك. هي سمعت بقصة بائعة اللين.</p> <p>مريم : لا لم اسمع من هي بائعة اللين</p>  <p>عبد الله يجيب : في إحدى الليالي، خرج أمير المؤمنين عمر بن الخطاب رضي الله رضي الله عنه ومعه خادمه أسلم، ومشياً في طرقات المدينة للاطمئنان على أحوال الناس وبعد مدة شعرا بالتعب من كثرة المشي، فوقفوا يستريحان بجوار أحد البيوت، فسمعا صوت امرأة عجوز داخل هذا البيت تأمر ابنتها أن تخلط اللين بالماء، قبل أن تبيعه للناس، فرفضت الابنة أن تغش اللين بالماء، وقالت لأمها: إن أمير المؤمنين نهى أن يخلط اللين بالماء فألحت الأم في طلبها، وقالت لابنتها: يخلط أين عمر الآن؟! إنه لا يرانا. فقالت الابنة المؤمنة ونعصيه.. الأمانة: وهل تطيع أمير المؤمنين أمام الناس في السر فسعد أمير المؤمنين بما سمعه من هذه الفتاة، وفي الصباح سأل عنها فعلم أنها أم عمارة بنت سفيان بن عبد الله الثقفي، وعرف أنها غير متزوجة، فزوجها لابنه عاصم، وبارك الله لهما فكان من ذريتهما الخليفة العادل عمر بن عبد العزيز.</p>	<p>Abdullah the Tutor: To worship Allah as if you see Him, for though you do not see Him, surely He sees you. Have you heard the story of milkmaid?</p> <p>Mariam: No I haven't.</p> <p>Abdullah the Tutor: One night, Umar as usual went to see the condition of the people. The Caliph heard a whispering talk within. The mother told her daughter to mixed water with milk, and that led to considerable profit. The daughter said, "Have you forgotten the Caliph's order? He wants that the milk should not be adulterated." The mother said, "But there are neither the Caliph nor any of his officers here to see what we do. The girl refused to fall in with the plan of her mother. She said, "You may escape the notice of the Caliph and his officers, but how can we escape the notice of Allah and our own conscience?" The Caliph called his sons, and addressing them said "Here is a gem of a girl who would make a great mother. I desire that one of you should take this girl as wife. Asim the third son was yet unmarried, and he offered to marry the girl. From this union was born a daughter Umm Asim, who became in due course the mother of Umar bin Abdul Aziz. Umar bin Abdul Aziz became a Caliph in due course.</p>
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Table 7.2 Abdullah ATA-CITS Conversation Transcript

7.3.2. Adaptation of the scripting language

The scripting language was adapted to include new variables that would accommodate the implementation of the learning theories into the CITS. The new variables added to the scripting language are utilised by the engine in order to adapt the tutoring method and content based on the student's knowledge level and understanding.

The knowledge level and understanding exhibited by the students is measured throughout the tutoring session by the system through monitoring several key variables that relate to the student's performance within the tutoring (see section 7.3.4.1 for the student model). This information is utilised to change the tutoring methods and style by the engine through the scripting language.

7.3.2.1. Inclusion of Learning Theories

The scripting language were adapted to include new variables that allowed the engine to adapt the tutoring session with the appropriate learning method/theory (see chapter 4 section 4.3.2 for learning theories). As described in chapter 5-section 5.3.1.6, the scripting language contains variables that store High, Low and Default answers. These variables were utilised at this stage to also include the suitable learning theory/method that is appropriate for each of these levels. The new variables added to the scripting language are as follows:

- High, default, and low answers and responses
 - each rule is linked to 3 possible answers and responses
- Time Threshold
 - Each rule will have a time threshold associated with it, which will be the acceptable time within which the user should answer the question (see section 7.3.2.2 for further explanation on time threshold).
- Extra context
 - The general life in Manchester, and Jordan sub context.
 - The students behaviour/attitude in class sub context.

The engine can now use the student/learners utterances/answers to measure the level of knowledge in order to adapt the learning theory/method delivered during the tutoring session. For example, if the student consecutively provides low-level answers then the engine will classify that student having low-level subject knowledge or the student is struggling with the tutoring content. Thus, the new architecture will utilise the new variables stored in the scripting language, in order to adapt the learning method/theory of the tutoring session. In the example explained (i.e. the student consecutively provides low-level answer), the engine will find that the low-level answers have Gagne theory associated with them. This means the CITS will change the tutoring content delivered to the user according to this theory. This will result in more 'prior recall' to previous tutoring questions to reiterate tutoring content and the tutoring presentation will be adapted to include more pictures, sound and media etc.

The new variables added to the scripts such as (answers classification, tutoring rules classification, and time threshold), work together with the components of Abdullah's ATA-CITS engine to facilitate the adaptation of the learning theory to suit the individual learner's level.

The new scripts now store the recommended tutoring style, and content (level of question, associated media etc.) based on the learner's knowledge. The delivered learning theory/method is adapted at the end of each tutoring sub-context in a tutoring session. This is when the engine calculates the student's accumulative/average score, and based on this score the learning theory is adapted for the next tutoring context to suit the accumulative/average score achieved by that particular user (see section 5.3.2.2.3 in chapter 5).

7.3.2.2. Tutoring specific variables for rules

As described in (Chapter 5 section 5.3.2), the pattern matching approach to scripting organizes conversational scripts into contexts consisting of a number of rules which themselves consist of a number of patterns and a stimulus response pairs in the CA's knowledge base.

A rule as illustrated in (section 5.3.2); can have a number of different patterns that might be matched with a user's utterance. A novel feature is implemented in the rules part of the Abdullah ATA-CITS PM scripting language at this stage, which is:

- Rule Time Threshold
- High, default, and low answers and responses

The rule time threshold is a variable added to each rule. Each tutoring rule now has a time threshold associated with it. The time threshold is used to detect confusion or struggling/misunderstanding from the user. Once a rule is fired and the user does not respond within the specified time threshold Abdullah ATA-CITS automatically re-presents a rephrased version of that question in order to make the question more understandable for the user.

A suitable time threshold for each group of questions is pre-determined through interviews and consultation from the Islamic tutors (see section 5.3.1.2.2 for tutor interview). The more in depth or complex the question that is defined by the Islamic tutor the longer the time threshold given for example a question about monotheism is given a longer time threshold than a question related to the facts about the Prophet Muhammad's life.

The answers classification (high, default, and low), is another variable added to each of the tutoring rules. This variable links each of the tutoring rules to the three different levels of answer and response. The answers are patterns for the utterances to be match to in order to determine the level of the answer provided by the student. The responses is the reply that will be delivered by the CITS according to the level of the answer given by the student and the level of understanding measured during the tutoring session.

7.3.3. Developed Arabic CITS Knowledge Engineering

The intention behind the developments made to the Arabic CITS knowledge base (KB) were to enhance the KB to suit to the target user's age range (10-12 years old). This involved as discussed in section (7.3.1), the further development of the KB through knowledge engineering and the implementation of new tutoring sources for example the Tafsir table in the Islamic database.

7.3.3.1. Developed Knowledge Engineering Arabic CA domain

The domain used to script the Arabic CA is concerned with teaching the students between (10-12 years old), the three principals that every Muslim must learn which is to know Your God (Allah), his messenger (Prophet Muhammad), and the religion of Islam, with the supportive evidences (Quran and Hadith). Abdullah ATA-CITS is designed to target this age group specifically because at this age group most Arabic children are able to construct coherent sentences in addition to this at this age the children are mature enough to grasp and understand the basic concept of Islam.

7.3.3.2. Tutorial Knowledge Base Expansion

The tutorial knowledge base (TKB) is one of the core components that responsible for managing and directing the user in the tutoring session by managing the tutoring topics and all related subtopics to the user.

In the Abdullah ATA-CITS, all the tutorial questions are organized in the TKB as questions with answers in a low, default, and high level answers. During the tutoring session, a number of questions and their corresponding answers are delivered to the user based on the systems determination of the users' level of Islamic knowledge.

Once the system has gained enough information about the user's level of knowledge, it is able to adapt the questions and the answers within the tutorial session to best match that user's Islamic knowledge (section 5.3.2.4). In order to make the TKB more suited towards the target age group (10-12 years old), a new contexts were developed and added to the knowledge base which were more specific to the target age group (see section 7.3.3.3 for further details on the new context were add to the Abdullah ATA-CITS).

7.3.3.3. The developed Arabic CA KB Scripts

The new Arabic CA scripts developed in Abdullah ATA-CITS was created initially from the Abdullah CITS Arabic CA scripts (which have been designed in the development of Abdullah CITS illustrated in Chapter 5).

In the updated Arabic CA scripts, which is implemented in the new architecture of Abdullah ATA-CITS, new contexts have been added to the current Arabic CA. The intention of the added scripts are to make Abdullah ATA-CITS more suited to the target age group (10-12 years old). The original Arabic CA scripts used in Abdullah CITS contains five main contexts, which are:

- The initialization context
- To know your God context.
- To know your prophet Muhammad context.
- To know your religion context.
- The general context.

The new developed Arabic CA scripts includes all the scripts implemented in Abdullah CITS as well as the additional contexts, which included the kids/children context, as well as a number of sub context were added into the general context in the Abdullah ATA-CITS.

These new contexts will enable the CA to converse with the targeted aged groups (10-12 year old) using both modern and classical Arabic language as illustrated in Table 7.3. The general context implemented in Abdullah ATA-CITS includes a number of sub-contexts such as (Abdullah the tutor, students in the class, life in Manchester, life in Jordan, and general advices sub-context). Abdullah the tutor sub-context are responsible to introduce the tutor (Abdullah) to the user and to covering a personal information about Abdullah the tutor.

The developed Abdullah ATA-CITS is able to manage, and control the student behaviour in the class by implementing the 'student in the class' and 'general advices' sub-contexts.

For example, the knowledge added in the 'student in the class' sub context was added based on the interviews with the Islamic tutors (see section 5.3.1.2.2 for the finding from Islamic tutor interviews). This sub context contain specific rules that relate to the everyday behaviour/attitude of young students in Islamic education.

During the tutoring session, when students complain about a fellow student in the class or other off topic discussion, Abdullah ATA-CITS will be able to respond to these types of utterances appropriately. In addition to this, the updated Arabic scripting language of Abdullah ATA-CITS also implement other two sub-context which are (life in Manchester and in Jordan), to cover aspects and familiar general facts about these two cities.

The implementation of these new contexts (Table 7.3) to the knowledge base make the knowledge base more suited towards children. It includes further knowledge that can be utilised by Abdullah ATA-CITS in order to make the tutoring better for the target age range and deal with the more unpredictable behaviour of children.

Contexts	Sub-context	Implemented in Abdullah CITS	Implemented in Abdullah ATA-CITS
1. Initialization context	a. Starting sub-context	Yes	Yes
	b. User's Name and Gender sub-context	Yes	Yes
2. To know your God	a. The Oneness of God in His Lordship sub-context.	Yes	Yes
	b. The Devotion of All Worship to the One God Alone sub-context.	Yes	Yes
	c. The Uniqueness and Oneness of God in His Names and Attributes sub-context.	Yes	Yes
3. To know your Prophet Muhammad	a. Birth of Prophet Muhammad sub-context.	Yes	Yes
	b. The first forty years sub-context.	Yes	Yes
	c. Al-Hijra sub-context.	Yes	Yes
	d. The Battle of Badr sub-context.	Yes	Yes
	e. The Battle of Uhuh sub-context.	Yes	Yes
	f. Conquest of Macca sub-context.	Yes	Yes
4. To know your religion	a. The five pillars of Islam sub-context.	Yes	Yes
	b. The six pillars of Faith sub-context.	Yes	Yes
5. General	a. Abdullah CITS sub-context.	Yes	Yes
	b. User's general advices sub-context.	Yes	Yes
	c. Life in Manchester sub-context.		
	d. Life in Jordan sub-context.	----	Yes
	e. Abdullah the tutor sub-context.	----	Yes
6. Kids	a. Students in the class sub-context.	----	Yes
	b. Kids general advices sub-context	----	Yes

Table 7.3 Abdullah ATA-CITS contexts

7.3.3.4. Abdullah's ATA-CITS Conversational Agent

The CA of Abdullah's ATA-CITS labelled as component 2 in Figure 7.1 is made up of four modules, which are (the conversation manager, the controller, pattern matching, and short text similarity). Enhancements were made to the following modules, in order to provide a CITS, which is more robust, and adapting to the tutoring content:

- A. Short text similarity (section 7.3.3.5)
- B. The conversation manager (section 7.3.3.6)

The enhancements made to each of these modules, will be described in the following sections.

7.3.3.5. Modified Short Text Similarity (STS) in Abdullah ATA-CITS

The STS measure that was implemented in the first prototype of Abdullah CITS (STS1, Equation 11), was further developed in order to make the new STS measure (STS3, Equation 13) more strengthened in the updated architecture of Abdullah ATA-CITS.

The updated architecture of the STS measure has been further developed in Abdullah ATA-CITS in order to address the shortcoming of the first measure (STS1). The new STS measure (STS3) is based on a combination of the original measure (STS1) with an additional equation (STS2). The STS2 takes into consideration more language features such as removing the stop words from the utterances in order to calculate the similarity between the user utterances and the Islamic Database (Quran, Hadith, and Tafsir).

Both equations (Equation 11, and Equation 12 respectively), come together to form the final STS3. The final equation (illustrated in (Equation 13)) is used in Abdullah ATA-CITS to calculate the similarity strength between utterances, and the knowledge base and the Islamic database.

$$Similarity(1)_{1-2} = \frac{(N_{1-2} + N_{2-1})}{T_{1\&2}} * 100 \quad Similarity(2)_{1-2} = \frac{2 * |A \cap B|}{|A| + |B|} * 100$$

Where:

N_{1-2} = the total words of sentence 1 found in sentence 2

N_{2-1} = the total words of sentence 2 found in sentence 1

$T_{1\&2}$ = the total words of both sentence 1 and 2

Where:

$|A \cap B|$ = The intersect of sentence one and two, after removing the stop word, and word reputation.

$|A|$ = Sentence 1 after removing the stop word, and word reputation

$|B|$ = Sentence 2 after removing the stop word, and word reputation

Equation 11 Abdullah STS1 (Illustrated in section 5.3.2.2)

Equation 12 the developed STS2

$$Similarity(1)_{1-2} = \frac{(Equation1 + Equation2)}{2} * 100$$

Equation 13 Abdullah STS3

It was found through the evaluation of the first Abdullah CITS that the STS1 needed some improvement. Upon investigation of the log file, it was found that the main weakness of STS1 was in its similarity calculation between user utterances and the Islamic database.

The STS1 measure performed its similarity calculation on the raw unprocessed user utterances, which had an adverse effect on the similarity calculation due the inclusion of conjunctive words (e.g. if, is, a, an, or). Since these words are very frequently used in most sentences, STS1 on occasion selected/matched the wrong response from the Islamic Database.

In light of these findings a new STS measure STS3 was developed, the new measure pre-processes the user utterance before matching it to the Islamic Database, which is illustrated in Equation 13. This pre-processing step involves first removal of conjunctive and repeated words from the utterance. It was found that STS2 was more accurate than STS1, thus the new STS measure (STS2) was used in combination to the first STS1, which together form the final STS measure used in Abdullah ATA-CITS (STS3).

STS3 calculates the average result of both STS measures (original STS1 and new STS2), which gives a stronger more accurate match to responses from the knowledge base as it more focused on the important key words of the utterance. Through testing, it was found that the new measure is more accurate at matching with the knowledge sources than the first as illustrated in section 7.3.3.5.3. The new STS measure (Abdullah STS3) will be used in Abdullah ATA-CITS to extract the responses from Islamic DB (i.e. Quran, Hadith, and Tafsir tables) in the case where there is no matching with the Arabic CA scripts.

As described in chapter 5 (section 5.3.1.2), the knowledge extraction process is made up of two phases which are the extraction of knowledge from the Arabic scripts and the Islamic DB (Quran, Hadith and Tafsir) using the STS measure. In the updated knowledge base, the knowledge is also extracted using the new STS measure from an unstructured source, which is the Tafsir text.

Next section will outline how the final STS measure works to extract knowledge from the Islamic DB. The new measure provides additional functionality and robustness to Abdullah ATA-CITS by allowing the system to search through structured and unstructured knowledge base resources in the CAL in order to find a stronger more appropriate match to the user utterances that are not matched with the scripts.

The updated measure is more accurate than the first, therefore the user can ask general questions that are not scripted in the knowledge base, and Abdullah ATA-CITS is able to find appropriate responses for these questions/utterances from the Islamic database resources. Additionally, this will encourage the user/student to converse more in the CAL as the system will be able to recognise and responded more accurately to utterances in CAL.

7.3.3.5.1. Abdullah's ATA-CITS Short Text Similarity Extraction process for Quran Table

The new STS (STS3 illustrated in section 7.3.3.5) allows the user's utterances to be matched to the holy Quran when there is no match with the Arabic CA scripts as discussed in section (5.3.3.3). Figure 7.4 shows the process of how the STS3 measure is used to extract appropriate verses from the Quran based on the user utterance.

The holy Quran table will be searched based on topics related to keywords (a structured database containing the keywords like praying, charity, and fasting with all verses associating with these keywords). The Quran table is stored as text without the diacritics marks so that the user utterances can be matched without the need for proper diacritical marks. This keyword based approach is preformed first as it is less intensive than searching the whole text. If this process fail to yield a match, then the entire Quran text is searched for a relevant match based on the STS threshold.

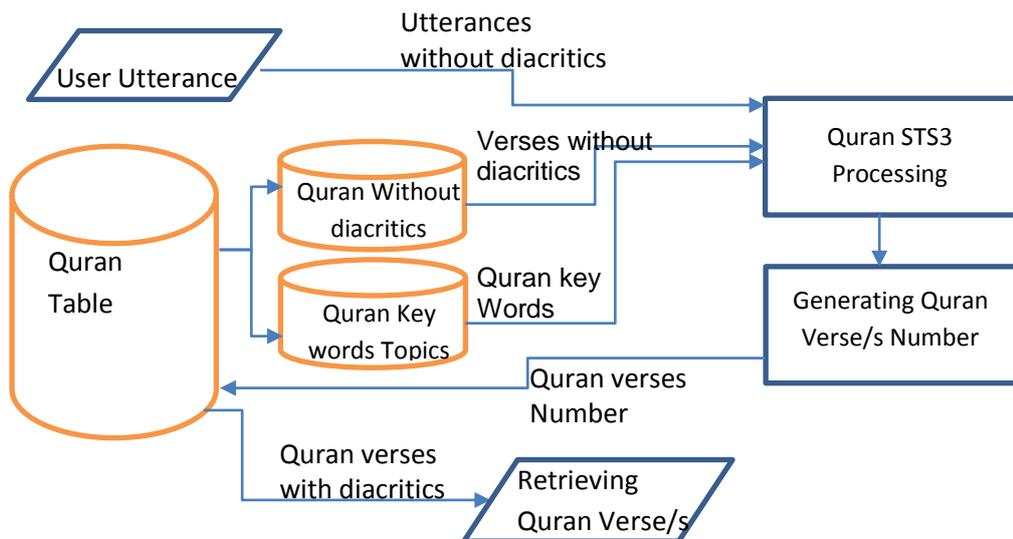


Figure 7.4 Abdullah's ATA-CITS Quran Processing Level

However, if there is no match to the CA scripts the STS3 measure is utilised to provide answers to the user with appropriate verses from the Quran. For example, when a user responds to a question with some words/verses from the Quran (indicating a higher level of understanding) Abdullah ATA-CITS will be able to recognise the words/verses from the Quran from the user utterance and provide a verse from the Quran to complement the scripted answer. This is illustrated in Figure 7.5 where the user responded to the question with some words from the Quran, as this was the correct answer Abdullah ATA-CITS replied with encouragement and a higher level of response.

<p>عبدالله المعلم : هل تعلم ما عقوبة تارك الصلاة ؟ محمد يقول : الله وعدهم بالويل والنار</p> <p>عبدالله المعلم : احسنت , قال الله تعالى " قَوْلٌ لِلْمُصَلِّينَ (٤) الَّذِينَ هُمْ عَنْ صَلَاتِهِمْ سَاهُونَ (٥) . سورة الماعون</p>	<p>Abdullah the Tutor: Do you know what the Consequence of leaving Salat.</p> <p>Muhammad saying : Allah promise them with a punishments, and woe in the judgment day</p> <p>Abdullah the Tutor: Excellent, Allah said in Quran "So woe to those who pray (4) [But] who are heedless of their prayer - (5)". Al-Ma'un 4-5</p>
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Figure 7.5 Quran STS Example

In the example illustrated in Figure 7.5, the scripted/expected answer from the user is highlighted in red, however as the user also provided supporting words from the Quran (highlighted in blue) in the answer. Abdullah ATA-CITS recognised the Quran words and added the appropriate verse to support the scripted answer (highlighted in green).

7.3.3.5.2. Abdullah's ATA-CITS Short Text Similarity Extraction process for Hadith Table

Extracting Hadith from the Islamic Database consider as the second attempt to find a match with the Islamic database after the matching with the Quran table is failed (see Figure 5.13 Conversation Flowchart in chapter 5). Through the evaluation of the first prototype system (Abdullah CITS), it was found that the extraction process from the Hadith table was yielding incorrect responses. This was due to the weaknesses of the STS measure (STS1), described in section 7.3.3.5.

The short text similarity (STS1) has been developed further in order to find a better match compared to the matching process used in the first Abdullah CITS prototype. Also in Abdullah's ATA-CITS, the extraction process of a response from the Hadith table, involves several steps illustrated below:

- a. Removing the Hadith Sanad (the chain of narration), as illustrated in Figure 7.6.
- b. Removing any character except the known 28 Arabic alphabet letters. This process will make sure that the Arabic diacritics are removed.
- c. Try to find a match from the Hadith 'Matn', using the new short text similarity (STS3), which developed in Abdullah ATA-CITS.
- d. Try to find a match from the Hadith 'Taraf', using STS3.

By implementing the above mentioned processing user utterances have more chances for a matching with the Matn of Hadith (the content of Hadith) only as illustrated in Figure 7.6. This will ensure that the matching process with hadith are more strengthened/accurate by matching only with a particular part of hadith that the user/students targeting it, in comparison to the matching process in the first prototype system (Abdullah CITS) that match with the full hadith components.

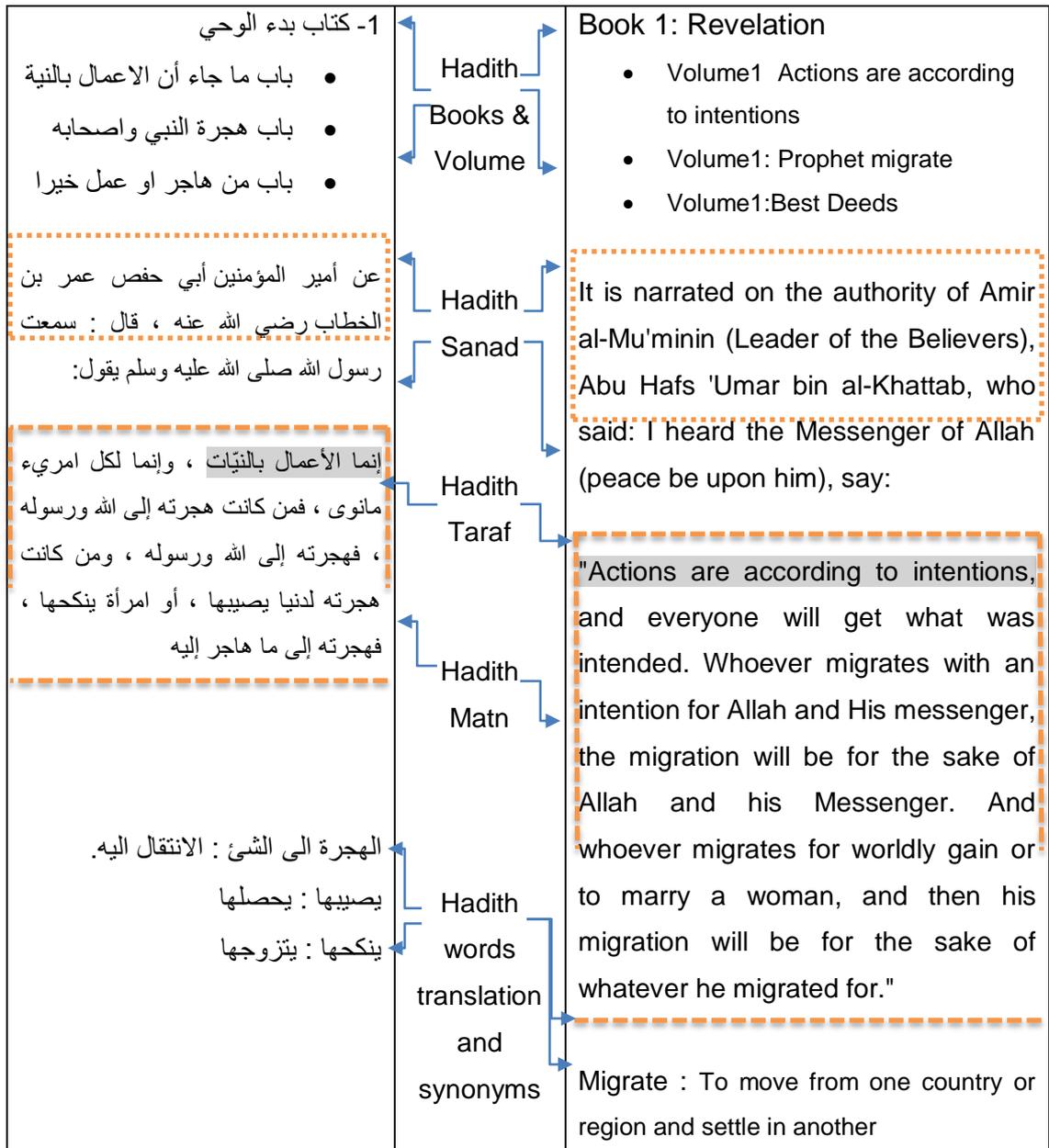


Figure 7.6 Hadith Components

Two approaches have been implemented in the STS3 within Hadith table. The first approach is try to measure the similarity between user utterances and the Hadith Matn. While the second approach is activated when the similarity threshold value from the first approach is below (40%) (I.e. there is no match with the 'Matn'). The second approach is trying to match the user utterances with the Hadith Taraf. The Hadith 'Taraf' is a condensed indication to the Hadith's content and it contains the key words used in the hadith as well as translations and synonyms of the Hadith content.

However, if there is no match with the Hadith table the conversation manager will try find a match with the last source of Islamic database (the Tafsir), as illustrated in the next section (7.3.3.5.3).

7.3.3.5.3. Abdullah's ATA-CITS Short Text Similarity Extraction processes for Tafsir Table

The new developed STS (STS3) is used within Abdullah ATA-CITS to extract the responses from unstructured text (i.e. Tafsir), by measuring the similarity between user utterances and the Tafsir table.

To illustrate the process of the newly developed STS3, assume this example (Table 7.4), which is taken from the log file of the first evaluation (Appendix 2 Dialogue 1).

User Utterance:

User Utterance:	S1 = (استخدم ابرهه جيش من الافيال فلما وصل جيش ابرهه مكة)
User utterance after removing the conjunctions words	| S1 | = (استخدم ابرهه جيش من الافيال فلما وصل جيش ابرهه مكة)
English translated utterance	S1 = (Abraha uses an army of elephants, and when they arrived to Mecca)

The extracted response (from Tafsir):

User Utterance:	S2 = (جاء ابرهه ومعه جيش كبير تتقدمه الافيال لهدم الكعبة في مكة)
User utterance after removing the conjunctions words	|S2| = (جاء ابرهه ومعه جيش كبير تتقدمه الافيال لهدم الكعبة في مكة)
English translated utterance	S2 = (Abraha came with a large army that includes elephants, to demolish Al Kaaba in Mecca)

Table 7.4 Tafsir's utterance example

According to the first short text similarity (STS1), which was implemented in Abdullah CITS, the similarity score obtained is as follows:

$$\text{Similarity}(1)_{1-2} = \frac{(N_{1-2} + N_{2-1})}{T_{1\&2}} * 100$$

$$\text{Similarity}(1)_{1-2} = \frac{(6+4)}{21} * 100 = 47.62 \%$$

By implementing the short text similarity (STS2) the pre-processed similarity, the similarity score obtained is as follows:

$$\text{Similarity}(2)_{1-2} = \frac{2 * |A \cap B|}{|A| + |B|} * 100$$

$$\text{Similarity}(2)_{1-2} = \frac{2 * 4}{6+9} * 100 = 53.33\%$$

The final short text similarity (STS3), which is implemented in Abdullah ATA-CITS, will compute the average between the two short similarities (STS1, and STS2). The final score value of the STS3 will be as follows:

$$STS2 = \frac{STS + STS1}{2} = \frac{(47.62 + 53.33)}{2} = 50.47$$

The average of the two equations is (50.47%), which is above the threshold values (50%). The Abdullah ATA-CITS will extract the response from all the Tafsir table and rank the similarity strength of all the responses that are above the threshold. The response that has the highest similarity average among all extracted responses will then be delivered back to the user.

In the example illustrated above it can be seen that STS1 assigned a strength value of 47.62 % to the response from the Tafsir table and the equation that pre-processes the user utterance assigned a value of 53.33% to the response from the Tafsir table. In the STS, measure (STS1) in the first prototype system (Abdullah CITS), this example would not have been classified as a potential answer.

However, with the new STS measure (STS3) implemented in Abdullah ATA-CITS this example answer will be classified as a potential answer as the average of both equations is 50.47%, which is above the threshold. The aim of the STS measure is to find a potential answer for user utterances that fail to match from the Arabic CA scripts, thus the threshold is set at 50% to find all possible related responses from the other Islamic Database. However, it is not necessary that the answer with 50% similarity is best match to be delivered, so the engine matches the utterance to the whole Islamic Database to find a match with the highest strength before it is then delivered back to the user.

7.3.3.6. Abdullah ATA-CITS Conversational Manager

In the first Abdullah CITS prototype, the role of the Conversation Manager (CM) is to manage the flow of the conversation; it is responsible for directing the user through the tutorial session to ensure the learning outcomes (goal) are achieved by ensuring the conversation follows the required path in the current context. It also controls the conversation context as well as it is responsible for changing the contexts as required. The CM has been further developed in Abdullah's ATA-CITS; and now contains additional features. In order for Abdullah's ATA-CITS to adapt the tutoring content and learning method to suit the user's level of knowledge. The new features of the CM are as follows:

1. The CM works together with student model (section 7.3.4.1) to track the student's level of knowledge and understanding. Based on this captured information the CM is responsible for adapting the tutoring content and teaching\learning methods to suit that particular user's level of knowledge and understanding.
2. The CM is also responsible for calculating the accumulative average score of the users' correct answers throughout the tutorial session and updating the student model with this score. Based on this score the system is able to determine the user's level of knowledge. Once the level of the users/learners knowledge is determined, the system is then able to adjust the tutorial session to suit that user's knowledge level.

These new features allow the developed Abdullah's ATA-CITS to adapt to different students' knowledge and understanding in order for the student to achieve the learning outcome of the tutorial session. These new features also make Abdullah's ATA-CITS more like a human tutor, as human tutors use many teaching methods/theories in order to teach students with differing levels of ability, knowledge, and understanding. This feature also gives the student more opportunities of learning the tutoring content, because if the system detects that the student is struggling with the tutoring content, action is taken by the system to adapt the content to suit that student, therefore increasing the chance of the student achieving the learning outcome.

7.3.4. Abdullah's ATA-CITS Intelligent Tutoring System

In order to develop Abdullah ATA-CITS, existing ITS components defined in chapter 4 section 4.2.2 will be adapted. In addition the student model, and the tutor model, have been added to Abdullah ATA-CITS in order to create an adaptive CITS. These new modules had to be researched and developed. The development of these modules is detailed in the following sections.

7.3.4.1. The Student Model

The student model is a representation of the student's existing state of knowledge at a certain time, it can store information regarding learner's knowledge on the particular tutoring topic based on certain key information captured during the tutoring session. Therefore, the student model plays an important role in assessing each individual student's knowledge and behaviour demonstrated during the tutoring session to measure the current knowledge level of the learners. The student model within Abdullah ATA-CITS presented three types of information to maintain the learner's model. This information is as follows:

1. Information about the student, which is as follows:
 - The name of a learner

- The gender of the learner
 - Determined automatically through the learner's name. If no name is captured then a default name is assigned (i.e. brother).
 - Learner's level of knowledge
 - This is capture and gauged during the tutoring conversation, it is set to default at the beginning.
 - The motivation of the learner (high, medium or low motivation)
 - This is also captured during the conversation based in the answers given by the student. It is set to medium by default and changed during the conversation.
 - learner pre-test score
 - The score achieved by the learner in the pre-test given to the user before the tutoring session starts.
 - learner post-test score
 - The score achieved by the learner at the end of the tutoring session.
2. Information about the students level of understanding of the tutoring topics, which is as follows:
- Does a learner have experience in a certain context
 - based on the level of answers giving by the user/student (see section 5.3.2.2.3 in chapter 5, for answer level)
 - What knowledge a learner has not mastered, or a learner has missed
 - (I.e. the learner is good in Quran but has no knowledge about Hadith). This is measured by counting the number of utterances that the user typing using CAL from the log file (see section 5.3.3.3 in chapter 5 for log file).
 - What answer did a student give to a certain question?
 - What is the average score of a learner in a certain topics?
 - The calculated accumulative score average throughout the discussion.

- How is the overall performance of a learner at any stage during the conversation?
 - This is based on the accumulative average question score.
- How many times a learner asks a questions not belonging to the current topic.
- How interested is a learner in a certain topic?
 - This is gauged through the responses provided by the user. (i.e. high, medium and low)
- What is the learner's level of understanding e.g. high, middle or low?
 - Based on the time it takes for the student to answer the question
- How well does a learner master a certain topic?
 - This is measured through the number of corrects answers to questions by the user, and their progression through the tutoring contexts.

All the above information is captured and stored in the student model. The student model is updated with the new information at the start of each new tutoring context, and through the tutoring session. The student model is used to gauge the understanding of the learner through the interactions with Abdullah ATA-CITS.

The student model seeks to assess the student's knowledge, and then adapt tutorial interactions accordingly to maximize learning gains. Kelly and Tangney (2006), defined learning gain as an effective tutoring measure which involves evaluating whether users have increased their level of understanding of the tutoring topics at the end of the tutoring session (i.e. Abdullah ATA-CITS).

In order to measure whether the users/students have increased their level of knowledge/understanding at the end of Abdullah ATA-CITS tutoring session. The learning gain will be measured using two variables scores, a pre-test score variable obtained before the Abdullah ATA-CITS tutoring session, and post-test score which is obtained after the tutoring session has ended (Kelly and Tangney, 2006).

These scores values (pre and post-test), will be compared to find whether there is any improvement in the user/students level of knowledge/understanding, by implementing the following equation (Equation 14).

$$\text{Learning gain} = \text{posttest score} - \text{pretest score}$$

Equation 14 Learning Gain

7.3.4.1.1. Temporal memory

In the temporal memory (Log file), the data about each learner will be stored during the tutoring session. The temporal memory (Log file) was produced for each learner, to enable Abdullah ATA-CITS to decide the type of response to give it back to the user.

The temporal memory was adapted to accommodate the storage of the new variables/information captured by the student model. For example, the time taken to answer a question and the accumulative average score of the students during the tutoring sessions.

7.3.4.2. The Tutor Model

The tutor model, as discussed in (chapter 4 section 4.2.2.3), is the model that is concerned about the instructional methods, such as choosing appropriate teaching methods that suit each individual learner. Learning theories focus primary on how the information is achieved, organized, and recalled.

According to the cognitive information process theory, there are a number of techniques that have been used to simplify learning such as, Gagne, and Piaget learning theories (Schulmeister, 2012). In addition to that Storytelling learning method can be utilised to simplify the learning and to encouraging students to share personal experiences (Gaeta et al., 2014).

The Abdullah ATA-CITS incorporates these learning theories and methods to deliver the tutoring session.

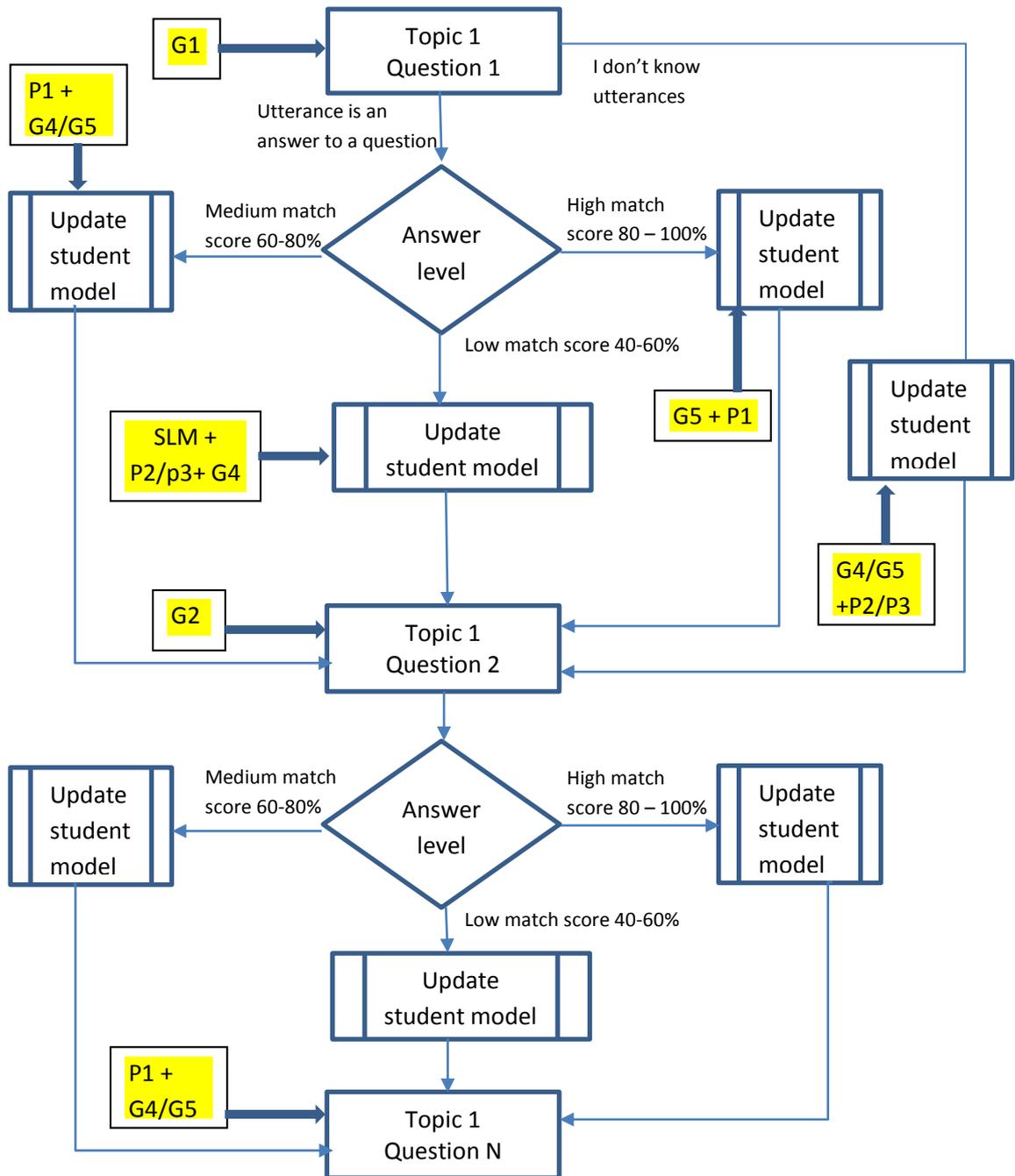
The main aim behind the implementation of these learning theories into the tutor model is to make Abdullah ATA-CITS a more rounded tutor. These theories allow Abdullah ATA-CITS to adapt and adjust the tutoring session based on the learner's interaction with the system.

Abdullah ATA-CITS is able to capture several variables to gauge the user/learners level of understanding and perception (stored in the student model, which is updated after each question) in relation to the tutoring subject.

The variables are used to adapt the session to most suit the learner and apply the different learning theories from the tutor model as required depending on the information stored in the student model.

Each of the tutoring session starts with the principles of the Gagne learning theory, which is to gain the learners attention and inform them of what the tutoring topic/subject is (illustrated in sections 7.3.4.2.1.1 and 7.3.4.2.1.2 respectively). The Gagne theory is the default theory that is applied to all the tutoring sessions during the first context.

When the student reaches, the end of the first context the conversation manager, and the student model are utilised to detect the level/understanding of the student (illustrated in chapter five section 5.3.2.4). Based on the information captured in the student model, the CM will apply events from additional learning theories and method to suit that particular learner's detected level and understanding during the next topic/context, as illustrated in Figure 7.7. For example if at the end of the first context the student model has detected that the student is struggling, then the CM will apply events from the Piaget learning theory which are stored in the tutor model, such as confusion detection and hint selection (see sections 7.3.4.2.2.2 and 7.3.4.2.2.3 for Piaget tasks). These events (illustrated in Figure 7.7), will adapt the tutoring in the next delivered context to offer more help to the student through visual hints, allow more time for the student to answer the questions, and adapt the questions to the low level of the tutoring. At the end of each tutoring context the CM calculates the accumulative average score of that particular tutoring session then based on this score the tutoring level of the next context is determined. This score value is used to determine the level of tutoring for the next context (i.e. low, default or high).



- Gagne learning theory
 1. Gaining learning attention (G1)
 2. Informing learners of the objective (G2)
 3. Stimulating recall of prior learning (G3)
 4. Presenting the tutorial content (G4)
 5. Providing feedback (G5)
- Piaget learning theory
 1. Learner's promotion (P1)
 2. Confusion detection (P2)
 3. Hint selection (P3)
- Storytelling learning method (SLM)

Figure 7.7 The triggered of learning theories/methods into tutoring session

The learning theories and methods implemented in the tutoring model will ensure that there is some level of learning gain, as opposed to an ITS with only one learning style that cannot adapt its tutoring. The next section will outline the implementation of learning theories/method into Abdullah ATA-CITS and how Abdullah utilizes them throughout the tutoring session.

7.3.4.2.1. Gagne Theory into Abdullah ATA-CITS

Gagne's theory outline a number of instructional events, which are briefly described along with a description of how they are applied in Abdullah ATA-CITS.

7.3.4.2.1.1. Gaining learners attention (reception)

Capturing learning attention is considered the first and the most important process for learning. Two techniques have been used to deal with this event in the design of Abdullah ATA-CITS:

- A graphical user interface (GUI) that begins with an animated title screen accompanied by sound effects, to increase children's visual orientation.
- Each lesson will start with a thought-provoking question or interesting fact about the selected topic to be taught as illustrated in (Table 7.5), curiosity motivates students to learn (Li, 2013).

Fundamental principles	Provoking Questions	
Fundamental 1	Let us start a conversation about the Prophet Muhammad pace upon him. Do you know in which city he born?	فلنبدأ بمحاورة عن الرسول محمد صلى الله عليه وسلم. هل تعلم في اي مدينة؟
Fundamental 2	Let us start a conversation about the greatest thing in the universe, It is the God. God named himself with ninety-nine names; can you tell me one of them?	فلنبدأ بمحاورة عن أعظم شئ في الوجود أنه الله سبحانه وتعالى , ولله أسماء حسنى "99" سمى بها نفسه , هل تستطيع اخباري بأحدها؟
Fundamental 3	Let us start a conversation about this greatest religion "Islam". Do you know what the word of Islam meaning?	فلنبدأ بمحاورة عن هذا الدين العظيم "الاسلام" . هل تعلم ماذا تعني كلمة الاسلام؟

Table 7.5 Provoking Questions in Abdullah ATA-CITS

7.3.4.2.1.2. Informing learners of the objective (expectancy)

To help the learners to complete the lesson and to achieve the goal of the presented topic, the learning objectives/outcomes must be listed early in each tutoring session. In Abdullah ATA-CITS an initial image is displayed at the beginning of the tutorial describing that on completion of the lesson, the learner will have:

- A brief understanding of the topic (the selected topic).
- Link to all the supportive evidence for the topic (Quran and Hadith).

Figure 7.8 illustrates the learning objective on the Five Pillars topic in the Abdullah ATA-CITS tutorial. This image is displayed to the user before the session begins.

THE FIVE PILLARS OF ISLAM

The Pillars of Islam

To know what the Five Pillars of Islam are and to be aware of their significance for many Muslims.

<p>1. The Shahadah – first pillar</p> <ul style="list-style-type: none"> • Belief in one God (Allah). • 99 Attributes of Allah. 	<p>2. Salah – the second pillar</p> <ul style="list-style-type: none"> • To know the five compulsory daily prayers • To recognise the main features and functions of a local Mosque. • To know about <i>Wudu (cleaning yourself)</i>, and <i>Ithan (calling for Salah)</i> • Stories e.g. (Bilal) 	<p>4. To know some of the key customs followed during Ramadan and Id-ulFitr.</p> <ul style="list-style-type: none"> • Times of fasting • Reasons for fasting • Qur’an – Laylat ul Qadr (Night of Power). • To learn (chapter Ul Qadr)
<p>3. Zakah- the Third pillar</p> <ul style="list-style-type: none"> • Stories and sayings of the Prophet • Why should we care for others? 	<p>5. To understand the importance of Makkah for Muslims throughout the world.</p> <ul style="list-style-type: none"> • The Kabah • Built by Prophet Ibrahim 	

Figure 7.8 Abdullah ATA-CITS Learning Objective

7.3.4.2.1.3. Stimulating recall of prior learning (retrieval)

Associating new information with prior knowledge can facilitate the learning process (Gagne et al., 2005). A simple way to stimulate recall is to ask questions about how well the learners understand previous concepts or the body of contents in general.

However all the tutorial questions are organized in the Tutorial Knowledge Base as questions with answers in a default style (A normal basic question which designed to suit different level of learner's knowledge), or as questions with answers in basic detailed style (A type of questions for the learner's with low level of knowledge). During the tutoring session, Abdullah ATA-CITS will measure the understanding of the tutoring topic by the learner by counting the number of correct default and detailed answers. Learner's knowledge will be measured during the tutorial by a number of variables, such as:

- The percentage of the correct answers.
- Whether or not the learners ask, a question related to the main topic.
- Have the learners provided any information using CAL (i.e. a verse from Quran or Hadith), this would indicate a high level of understanding.

7.3.4.2.1.4. Presenting the tutorial content

The tutorial content is designed to include all the necessary information the learner requires in order to achieve the learning outcome. The learning contents of Abdullah ATA-CITS were organized based on the books of Islamic education for year 5, and 6, which is used in primary schools in Jordan and in private supplementary Arabic schools in UK (i.e. Almanar). This book has been printed and organized by the Ministry of Education in Jordan (Al-Sadan, 2000, ash-Sheikh, 2010, Jordan, 2011). The topics were then structured using knowledge engineering subsequently Gagne learning theories were applied to give the tutoring a better structure to ensure effective learning was applied through the Abdullah ATA-CITS.

The system also utilizes a variety of media (i.e. text, and graphics) to appeal to different learning path depending on the user current knowledge, behaviour and dialogue (illustrated in Figure 7.9). Furthermore Abdullah ATA-CITS presenting an avatar (Figure 7.10), to illustrate the content of the tutoring to the student they struggled to provide the right answer (student types “do not know”).



Figure 7.10 Abdullah ATA-CITS Screen Shoot -1-



Figure 7.9 Abdullah ATA-CITS Screen Shoot -2-

7.3.4.2.1.5. Providing feedback (reinforcement)

As learners practice new topics it is very important to provide specific and immediate feedback on the learner's performance. The Abdullah ATA-CITS will display an appropriate encouragement after each correct answer, partially correct and low near miss answers, as shown in Table 7.6.

As an example, a match of 80% between utterance and pattern script is classified as correct answer and Abdullah ATA-CITS will respond with a message like "excellent God bless you" (as illustrated in section 5.3.2.2.3). Abdullah ATA-CITS can also provide an appropriate responses in case of learner's bad behaviour, or wrong attitude about the contents of the tutoring lesson.

	Abdullah ATA-CITS Tutoring Conversation	Abdullah ATA-CITS Encouragement
<p>عبدالله: هل تستطيع اخباري بأعظم الفرائض, التي يجب ان نقوم بها كل يوم؟</p> <p>المستخدم: إقامة الصلاة</p> <p>عبدالله: بارك الله فيك, الصلاة وهي الركن الثاني من اركان الاسلام . وهي الركن الوحيد الذي يستطيع المسلم اداءه في جميع الظروف, كيف ذلك؟</p> <p>المستخدم: الشخص المعاق الذي لا يستطيع الصلاة واقفا . يمكنه الصلاة في وضعية الجلوس</p> <p>عبدالله: بارك الله فيك, الصلاة وهي الركن الوحيد الذي يستطيع المسلم اداءه في جميع الظروف (الشخص المعاق الذي لا يستطيع الصلاة يمكنه الاستلقاء وتحريك رأسه للصلاة. الله سبحانه وتعالى شدد على اهمية الصلاة لماذا ؟</p> <p>المستخدم: احد اركان الاسلام</p> <p>عبدالله: جيد , قال الرسول محمد صلى الله عليه وسلم (أن أول ما يحاسب به العبد يوم القيامة من عمله صلاته).</p> <p>هل تعلم كم ركعة يجب صلاتها كل يوم؟</p> <p>المستخدم: 5</p> <p>عبدالله: جيد , ولاكن الاجابة الصحيحة هي 17 ركعة في اليوم.</p> <p>ممتاز لقد كان ادائك جيد في موضوع الصلاة</p> <p>هل تعلم ما هو الركن الثاني من اركان الاسلام ولهو علاقة بالمال</p>	<p>Abdullah: <i>Can you tell me the greatest obligations, we must do every day?</i></p> <p>User: perform Salah</p> <p>Abdullah: <u>excellent God bless you</u>, <i>Salah (prayer), is the second pillar of Islam. Salah It is the only pillar that Muslim can do it in any conditions, who is that?</i></p> <p>User: a disabled person who cannot stand for a pray. can pray in a seated position</p> <p>Abdullah: <u>excellent God bless you</u> Salah is the only pillar of Islam that person can do it in any conditions (i.e. a person who cannot stand or sit down can pray while lying down by moving his head.).God has stressed the importance of prayer, do you know why?</p> <p>User: one of the pillars of Islam</p> <p>Abdullah: <u>Good</u>, prophet Muhammed said, “The first thing one will be held accountable for on the Day of Judgment is prayer.” Do you how much prostration to God in a day during prayers?</p> <p>User: 5</p> <p>Abdullah: <u>Good, but I think the right answer is</u>, the Number of Rakaahs that are performed in the 5 Daily prayers is 17.</p> <p><u>Excellent you done well in Salah subtopic.</u> Do you know what were the second pillars of Islam, and it is related to money?</p>	<p>Excellent God bless you (user utterance is much closed to the stored perfect answer by Abdullah ATA-CITS).</p> <p>Excellent God bless you (user utterance is much closed to the stored perfect answer by Abdullah ATA-CITS).</p> <p>Good (user utterance are right but not the preferred answer).</p> <p>Good (user utterance belonged to current topic, but not the right answer).</p> <p><u>Excellent you done well in</u> (the type of encouragement given by Abdullah ATA-CITS, when most of the user utterances are right).</p>

Table 7.6 Abdullah ATA-CIT Providing feedback feature

7.3.4.2.2. Piaget theory into Abdullah ATA-CITS

Piaget learning theory diagnoses the cognitive processes by the learners through a number of highly interactive tasks aimed at learners aged 8-12 years old. The Piaget theory is implemented in Abdullah ATA-CITS, through the determination of the learner's level of perception and understanding related to the domain and delivering the information suited to that learner knowledge level. Abdullah ATA-CITS implements some relevant interactive tasks such as learner's promotion, confusion detection, and hint selection. Each of these tasks will be defined along with an explanation of how they are applied in Abdullah ATA-CITS in the following sections.

7.3.4.2.2.1. Learner's promotion

Learners with high level of cognitive development require fewer problems to solve than a learners with low level of cognitive development (Roll et al., 2011). For that purpose, Abdullah ATA-CITS is designed with a number of questions allocated for each sub topics covered during the tutorial. The learners will only be allowed to move from one sub topic to another when most questions related to sub topic been answered correctly.

7.3.4.2.2.2. Confusion detection

Learners with a low level of understanding require more time to solve problems, than learners with high level understanding (Felder and Brent, 2005). Thus, during the tutorial if the learners are identified to have a low level of understanding if they take a long time to answer a question. In this scenario, Abdullah ATA-CITS assumes that the learner is struggling with the tutoring content or the learners have not understood the question.

Therefore, Abdullah ATA-CITS will either rephrase the question or present the question with an illustrated media like (picture, or sound) to help the learner understand the question as illustrated in Figure 7.11.

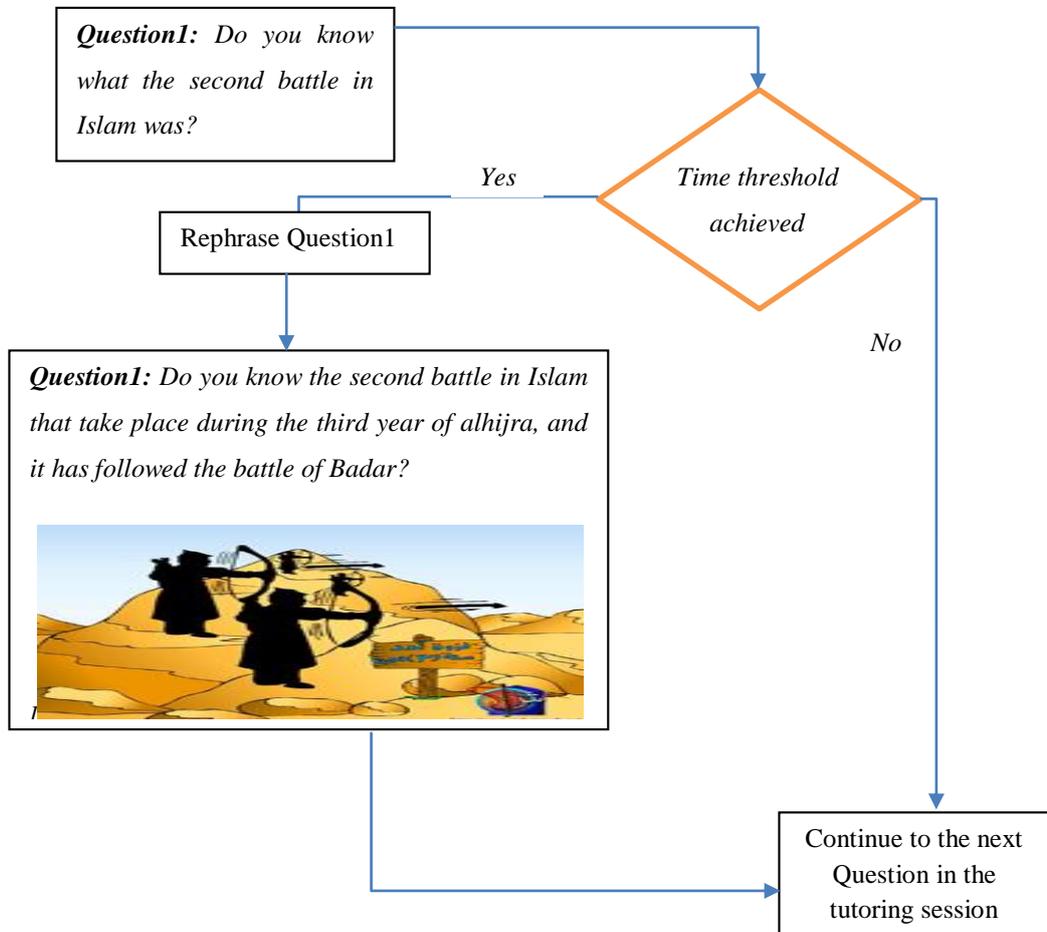


Figure 7.11 Abdullah ATA-CITS Confusion detection

7.3.4.2.2.3. Hint selection

Learners with low level understanding require more concrete visual hints, while the learners with high-level understanding need more abstract hints (He et al., 2009). As with the confusion detection, Abdullah ATA-CITS produces hints in the form of short sentences, pictures, and sounds to help the learner answer the question (as illustrated in Table 7.7).

As an example of hint selection is when the user/learner is struggling to answer a question related to the certain topic (i.e. charity topic), the hint will be delivered to the user in a form of short sentence (i.e. it is related to the money).

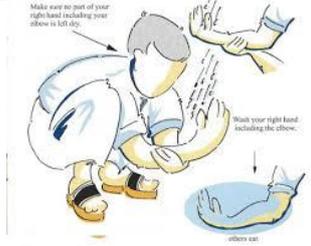
Topics or Question	Hints examples
Charity	Its related to the money
Hajj	You do it once in your life
in order to perform Salah	

Table 7.7 Hint Examples

7.3.4.2.3. Storytelling Learning Method into Abdullah ATA-CITS

Abdullah ATA-CITS implement a story telling based learning strategy allocated to support the adoption of knowledge to the learner. Abdullah ATA-CITS is able to generate multimedia presentations to tell the stories that are related to each topic in the tutoring session using a mixture of natural language, pictures, and sounds (Rahimtoroghi et al., 2013), as illustrated in Table 7.8. Furthermore, the tutoring content is structured and presented in way that groups the entire learning context into related sub topics. This ensure that each tutoring session has related content which promotes recall and transfer of knowledge into long term memory (Banaszewski, 2005).

CHAPTER 7 ARCHITECTURE AND METHODOLOGY FOR DEVELOPING AN ARABIC CITS TO ASSIST STUDENTS: REVIEW OF STUDENTS

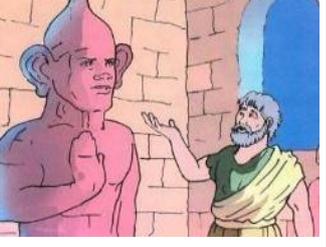
<p>الطاغوت كلمة مشتقة من الطغيان وهو مجاوزة الحد. ومن الامثلة الرائعة قصة ابراهيم ولد ابراهيم عليه السلام في قوم لا يؤمنون بوحداية الله تعالى , بل لم يجتمع قوم ابراهيم على عبادة اله واحد , فمنهم من كان يعبد الاصنام والتماثيل ومنهم من يعبد الكواكب والشمس والقمر , وطائفة تالفة تعبد الحكام من دون الله , وهل تعلم ما كانت مهنة والد ابراهيم عليه السلام؟</p>	<p>Juggernaut word is derived from the tyranny overstepping the limit. It is a wonderful story of Abraham examples Ibrahim, peace be upon him in the folk born do not believe in the oneness of God, but the people of Ibrahim did not meet on the worship of one God, some of whom had worshiped idols and some of them worshiped the planets and the sun and the moon, and a third range worshiped rulers without God. do you know what The profession of the father of Abraham</p>	
<p>في هذا المجتمع ولد ابراهيم , وكان والد ابراهيم اشهر صانع للتماثيل والاصنام , هل كان ابراهيم يحب هذه الاصنام ؟</p>	<p>In this society, Ibrahim was born, and his father was the maker of statues and idols. Was Ibrahim loves these idols?</p>	
<p>سأل ابراهيم ابيه يوما , أي تمثال هذا ان اذناه كبيرتان , قال ابوه أنه رب الارباب وهذه الاذنان الكبيرتان ترمز الى فهمه العميق. ضحك ابراهيم بينه وبين نفسه. ثم قرر البدء بالدعوة هل تعلم بماذا بدء؟</p>	<p>Ibrahim asked his father one day, any statue that this has a big ear. His father said that he is Lord of lords, and these large ears symbolize the deep understanding. Abraham laughed to himself. Then he decided to start preaching. Do you know with whom he started?</p>	
<p>أنهم عبدة الاصنام , ابراهيم دخل الى المعبد فوجد الطعام امام الاصنام فقال لهم ساخرا ألا تأكلون ؟ ما لكم لا تتلقون ثم هوى بفأسه على الاصنام وكسرها الى قطع صغيرة . ألا صنم واحد لم يكسره وجعل الفأس في عنقه كي يسألوه عن فعل ذلك , فهل تكلمت الاصنام</p>	<p>They are the worshipers of idols; Abraham went to the temple and found the food in front of idols sarcastically said to them not to eat? What you do not then Tinton Hui Fez on idols and broken into small pieces. Not fetish and one did not break it and make the axe in the neck in order to ask him who did the piece, will the idols spoke?</p>	
<p>ولما ذهب القوم الى المعبد وجدوا الاصنام كلها محطمة , فأحضروا ابراهيم وسألوه أنت فعلت هذا بالهتنا ؟ فأشار ابراهيم الى الصنم الكبير وقال :بل فعله هذا فسألوه ان كانوا ينطقون ! فقال قومه لقد علمت يا ابراهيم ان هذه الاصنام لا تتكلم فكيف نسألها . فقال لهم فكيف اذا تعبدون اصنام لا تتكلم ولا تدافع عن نفسها. فقرر قومه بأن يحرقوه , هل تعلم ماذا حدث بابراهيم؟</p>	<p>When people went to the temple and found all the idols broken, they brought Ibrahim and asked him Are you done this? Ibrahim pointed to the great idol and said: but do advantaged Vsalohm that they speak! He said his people have learned Ibrahim that these idols do not ask her how to speak. Ibrahim said to them how if you worship idols cannot speak or defend themselves. Qmoverm Ihrkoh decided that, you know what happened to Abraham peace be upon him?</p>	
<p>وحفر له قومه حفرة عميقة وأشعلوا فيها النار وألقوا ابراهيم فيها ولاكن الله سبحانه اناج من النار, ونصره على المشركين. بأي شيء أمرك الله به ؟</p>	<p>And his people dig a deep hole and set it on fire and threw it but God save Ibrahim from the fire, and the victory over the infidels. What is the God's order you?</p>	
<p>أمرني بالتوحيد ونهاني عن الشرك. ودليل الأمر قوله تعالى (إِنَّ اللَّهَ يَأْمُرُ بِالْعَدْلِ وَالْإِحْسَانِ وَإِيتَاءِ ذِي الْقُرْبَىٰ وَيَنْهَىٰ عَنِ الْفَحْشَاءِ وَالْمُنْكَرِ وَالْبَغْيِ</p>	<p>Told me about monotheism and polytheism Nahanni. Allah said in Quran “And your god is one God. There is no deity [worthy of worship] except Him, the Entirely Merciful, the Especially Merciful. “</p>	

Table 7.8 Storytelling Example in Abdullah ATA-CITS

7.3.4.3. User interface model

The user interface model deliver the means for the users/students to interact with the Abdullah ATA-CITS through a graphical user interface, it direct and translate the CITS internal illustration and the interface language that understandable to the students. In the user interface model Abdullah ATA-CITS can get the level of the students learning and affect, and then the CITS will suggest the right learning theory/method to deliver to the students. Thus, in the user interface model the teaching of the educational contents a longed with all learning theory/methods will apply in the Abdullah ATA-CITS to ensure the most of the attractive learning is delivered to the students.

7.4. Conclusion

The primary aim at this stage of the research was to adapt the original Abdullah CIT architecture to make it suitable for the target age group and to enhance the architecture to make it more effective and robust as a tutoring system. This chapter has outlined the enhancements and additions made to the original architecture in order to achieve the primary aim and to make the system more effective as a tutor. The original architecture was adapted and amended firstly based on the results of the first evaluation, the weaknesses highlighted during the first round of end user experiments were addressed. This involved the expansion of the knowledge base, further improvement of the ASTS measure to make it more accurate at matching MSA and CAL. The knowledge base expansion involved the implementation of new CAL resources to enhance the knowledge available to Abdullah ATA-CITS as a reference to answer student's questions and construct better responses, which include Islamic references to deliver back to the students, as a real Islamic tutor is able to do. In addition to this, the knowledge base was expand more through the implementation of additional rules, patterns and responses in order to address the shortcoming highlighted during the first evaluation. In addition to this several novel component have been researched and implemented into the architecture in order to make the Abdullah ATA-CITS architecture more robust and increase the overall effectiveness of Abdullah ATA-CITS as a tutor.

This involved in depth research into learning theories/methods and how these could be successfully implemented into the CITS architecture in order for the system to adapt the tutoring to suit individual learner's levels of knowledge and understanding of the tutoring topic. This led to the creation of the tutor model, which was incorporated into the architecture of Abdullah ATA-CITS. The tutor model includes several learning theories and methods, which the system can utilise, once triggered in order to adapt the tutoring session delivered to the students. This is achieved by monitoring several key aspects/variables (such as correct/incorrect answers, time taken to respond, response classification and fired rule) of the tutoring session with the student. Based on the outcome of these variables Abdallah ATA-CITS is able to adapt the tutoring content to suit individual learners/students detected level of knowledge and understanding of the tutoring topics. The main intention behind the addition of the tutor model was to make Abdullah ATA-CITS more like a human tutor. As human tutors are able to detect students who are struggling or not exhibiting understanding of the tutoring subject and are able to adapt the teaching method/style in order to make the subject more understandable for the student. Human tutors are also able to detect advanced students and provide them with more information and content to further their knowledge of the tutoring topic.

Furthermore, the GUI was adapted to make it more suitable and engaging for the target age group this involved the inclusion of an avatar into the system that acts as a focal point for the discussion with the children. In this regard, the researcher aimed to implement such a system into the architecture of Abdullah ATA-CITS to make the system more like a human tutor, and to increase the chances of learning gain for each student. The novel components and architecture enhancement will now undergo further end user evaluation to gauge the effectiveness and robustness of the new Abdullah ATA-CITS architecture. The end user evaluation will highlight whether or not the system is able to mimic a human tutor by successfully measuring and adapting the tutoring session to suit individual student's level of knowledge and understanding of the taught subject. The evaluation methodology and results are detailed on the following chapter.

CHAPTER 8 TEACHING ASSISTANT ARABIC CITS EXPERIMENTS**8.1. Introduction**

This chapter discusses how Abdullah ATA-CITS (the developed prototype of Abdullah CITS, which proposed in Chapter 5), was evaluated to see whether it achieved its objectives which were to teach students in the age ranged (10-12 years old), the three fundamental principles of Islam. Abdullah ATA-CITS implemented the learning theories/methods into the existing architecture to measure the success of the students in a particular tutoring method, as well as to test the ability of Abdullah ATA-CITS to adapt to the student's knowledge level.

Three experiments have been conducted in order to evaluate the effectiveness and robustness of the new system during the tutoring session, which is described in this chapter. These experiments are based around three hypotheses to test the success, effectiveness and the suitability of the tutoring of the new system. These hypotheses will be gathered from experiments involving the end users. The experiments will consist of gathering subjective and objective metrics through the participant's interaction with the system.

The results obtained from these experiments show that it is possible to implement an effective CA with ITS based on the learning theories and method in an Islamic educational environment which is aimed towards younger students.

8.2. Experimental Design

The prototype Abdullah ATA-CITS was evaluated through three initial experiments that were designed to gauge different aspects of the developed CITS. Experiments were conducted on Abdullah ATA-CITS to measure the full capabilities from different aspects such as tutoring success, user evaluation and system robustness. This section will outline the design of the experiments, as well as outlining the hypotheses devised for predicting the learning quality, suitability, and effectiveness of Abdullah ATA-CITS.

8.2.1. Hypotheses to be tested

The main hypothesis for the experimental studies are:

- **H1_0:** The success of students in a particular tutoring method is indicative of participant's knowledge improvement in the taught subject.

This hypothesis requires a conversational agent tutor to be scripted to deliver a tutoring session to students. Student performance and discourse during the tutoring session will be recorded and evaluated to identify patterns of activities, which may be indicative of the knowledge improvement in the taught subject (Schmelzing et al., 2013). As a teaching/learning aide, does Abdullah ATA-CITS make any progress to the students' knowledge on the taught subject (see section 7.3.4.1 for further detail on student learning gain).

- **H1_1:** The success of students in a particular tutoring method is not indicative of participant's knowledge improvement in the taught subject.

The success of the student is not related to a particular tutoring method, i.e. there is no relation to tutoring method and improvement in the taught subject.

- **H2_0:** It is possible to adapt to the student's knowledge level during tutoring discourse with an intelligent tutoring conversational agent.

As students have different levels of knowledge and understanding, can any link be found between the modern Arabic language used by the students and an intelligent tutoring system to interoperate their level of knowledge and understanding of the subject?. For example, is it possible for a CITS during a tutoring discussion to be able to monitor/measure the student's knowledge and understanding of the tutoring content, and adapt the tutoring to suit an individual learners level of knowledge (Brown et al., 2013).

- **H2_1:** It is not possible to measure and adapt to the student's knowledge level through tutoring discourse with an intelligent tutoring conversational agent.

An intelligent tutoring conversational agent cannot be used to identify and measure the student's level of understanding and adapt the tutoring discourse to suit a particular student.

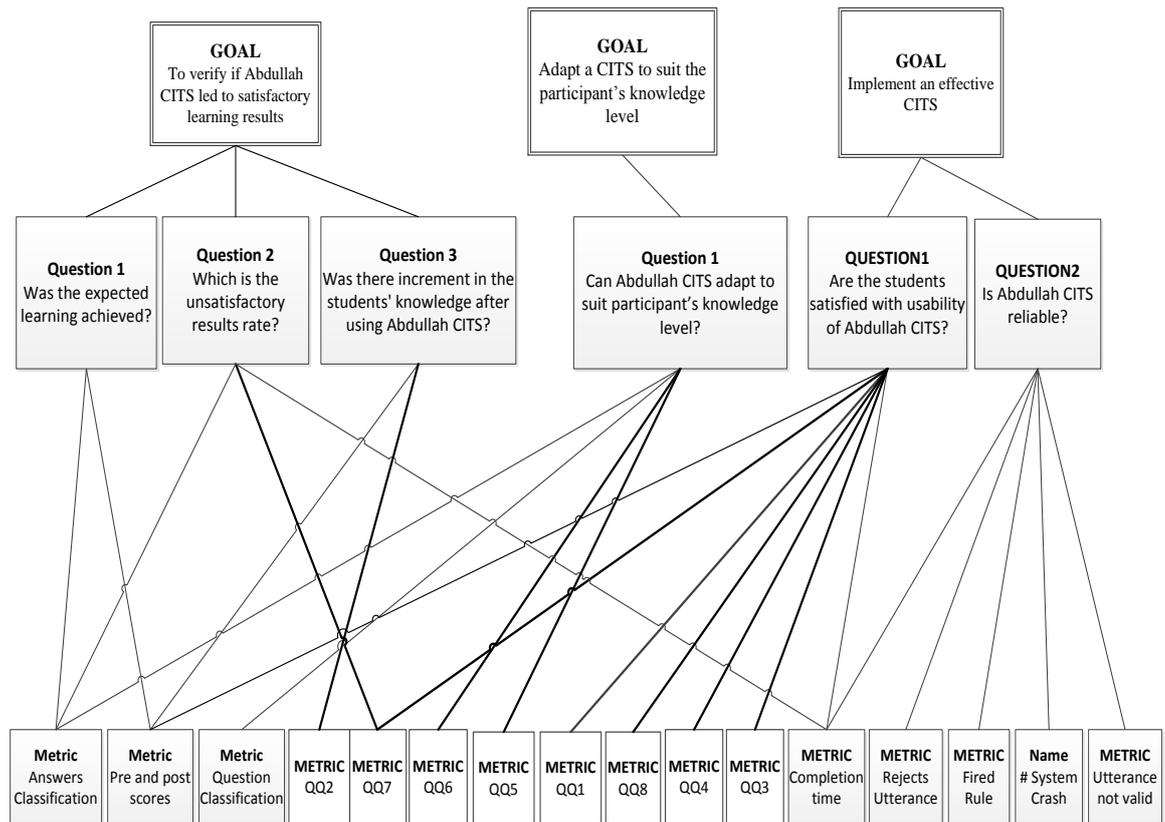
- **H3_0:** It is possible to develop a good quality Arabic CITS.

The quality of the developed system is defined to be: the totality of features and characteristics of the developed software (i.e. Abdullah ATA-CITS) that bear on its ability to satisfy stated or implied needs (Fenton and Pfleeger, 1998). However, quality is based on a number of factors/metrics such as reliability, and usability. The basic problem of reliability theory is to predict when a system will eventually fail, while the usability of a system is the extent to which the approach is suitable and useful to use (Boehm et al., 1978).

- **H3_1:** It is not possible to develop a good quality Arabic CITS.

8.2.2. Designing of Evaluation Metrics

The Abdullah's ATA-CITS GQM model illustrated in Figure 8.1 outlines a number of metrics that are required to successfully test the hypotheses defined in section 8.2.1. The metrics identified are a combination of subjective and objective metrics. The objective approach evaluates the CITS as a whole system by measuring a number of variables stored in the log file during the tutorial. Subjective evaluation uses a questionnaire, which is designed to gather qualitative user feedback following the Abdullah ATA-CITS tutorial.



QQ1 - Questionnaire Question1 "Percentage of the students enjoying using Abdullah the Tutor"

QQ2- Questionnaire Question2 "Percentage of the students who felt that they are learning from Abdullah CITS"

QQ3- Questionnaire Question3 "Percentage of the students who are remembering what Abdullah CITS Told in tutorial".

QQ4- Questionnaire Question4 "Percentage of the students they like the structure of Abdullah CITS topics"

QQ5 - Questionnaire Question5 "Percentage of the students that understand Abdullah CITS"

QQ6- Questionnaire Question6 "Percentage of the students who found Abdullah CITS delivering suitable amount of information to remember"

QQ7- Questionnaire Question7 "Percentage of the students who feels that Abdullah CITS Not overloads them with information.

QQ8- Questionnaire Question8 "Percentage of the students they like to use Abdullah the Tutor again"

Figure 8.1 GQM Model for Abdullah CITS Evaluation

8.2.3. Qualitative User Evaluation

The ability of Abdullah ATA-CITS to teach effectively was examined by user evaluation questionnaires, which was distributed to the student after the student's interaction with Abdullah ATA-CITS. Table 8.1 Shows the questionnaire which was designed to gather the students evaluation after the tutoring session. The questionnaire contains eight questions to be rated using the three-face scale (happy, neutral, and sad) instead of the Likert scale type method used during the evaluation of the first Abdullah CITS prototype (e.g., disagree and agree, or numbering scale) (Reynolds-Keefer and Johnson, 2011).

Questionnaires with pictures (the three-faces), have the ability to improve understanding in some situations where reading ability might create barriers such as with younger participants (Zhang et al., 2002). The questionnaire was amended to suit the target age group to make the scale more clear and understandable to the young participant who would be filling it in.

1. Abdullah the Tutor is enjoyable to use.			
2. There is too much to learn in one tutorial.			
3. Do you remember what Abdullah has told you in the tutorial?			
4. It is easy to follow the structure of the topics.			
5. Abdullah the Tutor provides me with information that I understand.			
6. Abdullah the Tutor does not provide too much information to remember.			
7. Abdullah the Tutor overloads you with information.			
8. Would you like to use Abdullah the Tutor again?			

Table 8.1 Abdullah ATA-CITS User Feedback Questionnaire

As shown in the previous table, students can rate each of the questions by selecting one of the three faces (happy, neutral, and sad); each of these faces has a value representing them (i.e. a value of 1 for the sad face, 2 for the neutral face, and 3 for the happy face).

After the tutoring session is complete students will evaluate Abdullah ATA-CITS, by selecting the most appropriate face representing their feeling against each of the eight questions. All the values then stored in log file for future analysis and feedback to students. The questionnaire is designed to answer the questions related to the hypotheses illustrated in section (8.2.1). The questions, and statements in the questionnaire as well as the relation to the hypothesis is summarised and outlined in Table 8.2.

Subjective Metrics	
Metric to be Evaluated	Characteristic Measured
1. Abdullah the Tutor is enjoyable to use.	Hypothesis 3
2. There is too much to learn in one tutorial.	Hypothesis 1
3. Do you remember what Abdullah has told you in the tutorial?	Hypothesis 3
4. It is easy to follow the structure of the topics.	Hypothesis 3
5. Abdullah the Tutor provides me with information that I understand.	Hypothesis 2
6. Abdullah the Tutor does not provide too much information to remember.	Hypothesis 2
7. Abdullah the Tutor overloads you with information.	Hypothesis 1,3
8. Would you like to use Abdullah the Tutor again?	Hypothesis 3

Table 8.2 Abdullah ATA-CITS Subjective evaluation metrics

8.3. Experimental Methodology

This section will describe the experimental methodology in testing the ability of Abdullah ATA-CITS to provide an effective tutorial. The tutorial that was given by Abdullah ATA-CITS is based on Islamic education, which is to teach the three fundamental principles of Islam for the selected age group (10-12 years old).

However, Abdullah ATA-CITS tutorial content is suitable for any students that can communicate in the Arabic language, and has a little or previous experience about the fundamental of Islam. All the selected participants have no prior experience of using or interacting with Abdullah ATA-CITS.

8.3.1. Participants Study

Fifty-eight students were chosen from two different primary schools based in Manchester UK, and Madaba Jordan. These students are between the age ranges of 10-12 years old (year five and year six).

All the 58 participants who were selected for the study were students in year five and year six primary school, whose first language was Arabic and who had little previous knowledge of the three fundamental principles of Islam (but with various levels of expertise). Typically, students of this age are taught the fundamentals of the Islamic religion from their parents. Fundamentals such as the basic principles of Islam (fasting, praying and monotheism).

8.3.1.1. UK Group

There were 38 students chosen from Almanar supplementary Arabic School, which were the Arabic language are the mother/main spoken language. All of these students came from a different ethnic backgrounds (i.e. Iraq, Syria, Saudi Arabia, Yemen, etc.), spoken English language as a second language, and were students in either year 5 or year 6. All the students were also attending English primary schools in Manchester UK.

Almanar supplementary Arabic school, is based in Manchester UK were the experiment took place. The students are attending this school one day a week (Sunday from 10 AM-3:30 PM); during this day, they learn Arabic and Islamic religion only. In order for the students to take part in the experiments, the researcher first, contacted the school head teacher to gain permission for the experiments to take place.

Once the head teacher had given approval, a letter was distributed by the school to the children's parents (see Appendix 5: Ethics Forms for the letter of consent, and ethics approval). Only the students who had been given consent by their parents took part in the experiments. All the data captured during the experiment was kept anonymous and all the data was destroyed after 6 months.

8.3.1.2. Jordanians Group

Twenty students from Alaalya School in Madaba Jordan were selected for the evaluation of Abdullah ATA-CITS. The selected students are studied the Islamic religion as a taught subject in the primary school curriculum of Jordan. Islamic education is a core part of the taught primary school curriculum of Jordan and every student has to learn the principles of Islam at an early age.

All the students in this group are Jordanian native Arabic language speaker's students between the ages of 10 – 12 years old (year 5, and year 6). Both of the participant groups (UK and Jordan) had representation of both genders and all participants selected were IT literate appropriate for their age group.

8.3.2. Abdullah ATA-CITS Experimental Methodology

All experiments were undertaken in a classroom/lab environment, and each students worked individually on a computer, on to which Abdullah ATA-CITS was loaded. The teachers were present and the students were given the instructions about using Abdullah ATA-CITS (i.e. students were giving the URL to logs on Abdullah ATA-CITS).

The system then randomly selected one of the three fundamental principles of Islamic religion (To know you God, to know your prophet, and to know your religion of Islam) to ensure each student followed a different learning path. During the tutoring session, the questions from the system, the student's answers, and conversation related variables (see Chapter 6 section 6.2) log file variables/metrics) were captured and recorded in the log file, for further analysis and to evaluate the success of the tutoring session.

The data gathered from the experiments was analysed to determine whether and how well Abdullah ATA-CITS taught the subject to the participants (i.e. effectiveness/robustness). There were three experiments designed to test the hypotheses in section 8.2.1, and each of the experiments will be described in detailed in the next section (8.4).

8.3.3. Abdullah ATA-CITS Students Interaction

To measure whether or not there was any learning gain achieved by the students through their discussion/interaction with Abdullah ATA-CITS during the experiment (see section 7.3.4.1 in chapter 7 for learning gain). Each student conducted a pre-test before they interacted with the system and a post-test after they completed the tutorial. The pre-test and post-test (El-Aziz El Naggar et al., 2013) contained questions related to the tutoring topics and were devised in consultation with teachers at Almanar School. The learning gain of the students can be measured by checking differences in the test scores. The higher scores in the post-test will indicate some learning gain from the student's interaction with Abdullah ATA-CITS. All student participants from both groups (UK and Jordan, Year 5 and Year 6), followed the following steps:

1. Pre-test (students were presented with a pre-test, consist of five T/F questions, five MCQ, single one word question, and a single one verse question). The pre-test and post-test are illustrated (Appendix 3: Pre and post test questions).
2. Students engage with Abdullah ATA-CITS in a directed two-way conversational tutoring session taking an average of 35 minutes.
3. Students at the end of the tutorial completed a post-test (which is the same test that have been given to the students before the tutoring session).
4. Students then complete a user feedback questionnaire, as illustrated in section (8.2.3).
5. Finally, Abdullah ATA-CITS presented participants with a comparison of their test results (indicating their learning gain) and some feedback on their tutorial performance.

8.4. Experimental Analysis

The data gathered from the experiments was analysed to determine whether and how well Abdullah ATA-CITS helped to improve the tutoring in the taught subject. There were three experiments designed to test the hypotheses in section 8.2.1. Each experiment has different analysis results, and now will be described separately.

8.4.1. Experiment 1: Tutoring Success

This experiment tested the hypothesis H1 defined in section 8.2.1 and was conducted to test the tutoring success of the Abdullah ATA-CITS. The data for this experiment was extracted from the log file, which records the dialogue between the user and the system. Fifty-eight participants were selected to engage with the tutoring system, they were instructed to complete an entire tutoring session, in line with the methodology described in section 8.3.

Subsequent to this, using the log file, the user's knowledge, and other behavioural factors were analysed to assess each learner's performance during the tutoring session by analysing a number of objective metrics captured and stored in the log file (illustrated in Table 8.3).

These metrics were used to answer the questions related to the first hypotheses, which are:

1. Was the expected learning outcome achieved? (see section 5.3.1.2 in chapter 5 for learning outcome)
2. What is the unsatisfactory results rate? (percentage/value)
3. Was there a gain in the students' knowledge after using Abdullah ATA-CITS?

These three question will help to answer the first research hypothesis, which is "H1 - The success of students in a particular tutoring method is indicative of participant's knowledge gain in the taught subject."

The metrics that will support the answering of this hypothesis are outlined in Figure 8.1.

Metric to be Evaluated	Mode of Evaluation	Subjective / Objective
Pre and Post Test	Log file	Objective Metric
Answers classification	Log file	Objective Metric
Completion Time	Log file	Objective Metric
Quality of tutorial	Questionnaire	Subjective Metric
Tutoring content	Questionnaire	Subjective Metric

Table 8.3 Experiment 1 Metrics

8.4.2. Experiment 1 Results and Discussion

This section will present the collated results of all five metrics outlined in Table 8.3, extracted from the tutoring log file and questionnaire (questions number 2 and 7, in Table 8.1 Abdullah ATA-CITS User Feedback Questionnaire). These two data sources (log file, and the questionnaire) will be utilised to measure the quality and the content of the tutoring according to the log file metrics and user's feedback.

8.4.2.1. Pre & Post Test - Results and Discussion

The generalized linear model (GLM) has been employed in this experiment to measure the learning gain (see section 7.3.4.1 in chapter 7) of the students by analyse the results of the pre-test and post-test scores achieved by the students within different grouping factors (i.e. Year group, Locations, and Gender). GLM can be used to fit a Poisson regression (In statistics, Poisson regression is a form of regression analysis used to model count data) for the analysis of count data (Hosmer Jr et al., 2013). Logistic regression is an instance of GLM, which consists of a large variety of exponential Models.

Zou and Donner (2013), mentions that the odds ratio in logistic regression measures the odds of an event compared to the odds of another event (i.e. to determine which factors are most prominent in effecting the tutoring within the factor groups).

The Generalized linear model can provide a framework for relating response and predictor variables, and it consists of three components, which are:

1. Random component: Identifies dependent variable, and its probability of distribution.
2. Systematic Component: Identifies the set of independent variables
3. A link function: link between random and systematic component g (i.e. Logit).

These components will be described with relation to the pre-test and post-test values obtained by the students/participants before and after a tutoring session with Abdullah ATA-CITS.

The Binomial probability distribution is used especially for dependent variables that represent a number of events occurring in the set of a trial (Forbes et al., 2011). The Post-test score is an example of the dependent variables used in binomial probability distribution, while the number of trials is fixed to 35 because the students can get a score starting from 1 to 35 as a maximum as show in Figure 8.2.

Events Variable	Post-test score
Number of Trials	35
Probability Distribution	Binomial
Link Function	Logit

Figure 8.2 Model Information

The statistical analysis of the results obtained from the pre-test and post-test shows that there is a strong statistically significant, difference (p value less than 0.001) between the students score before the tutoring (pre-test) and after the tutoring (post-test) as shown in Table 8.4. Table 8.4 also illustrates that there is also a strong statistically significant difference (p value equal to 0.001), between the students in year 5 and the students in year 6, independent of the students location (UK or Jordan). In addition to that the results also show that there is a significant difference (p value of 0.023) in the pre and post-test scores between the students who participated in the experiments with Abdullah ATA-CITS in the UK (location 1), and Jordan (location 2).

Additional finds from the pre-test and post-test score indicate that there is no difference between the gender groups (group 1 for girls, and group 2 for boys), (p greater than 0.05) as shown in Table 8.4.

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Wald Chi-Square	df	Sig.
(Intercept)	-2.692	.4357	-3.546	-1.838	38.164	1	.000
[Year Group=5]	.410	.1233	.168	.652	11.058	1	.001
[Year Group=6]	0 ^a	.	.	.	.	.	.
[Location=1]	.392	.1723	.054	.730	5.168	1	.023
[Location=2]	0 ^a	.	.	.	.	.	.
[Gender=1]	.083	.1119	-.136	.303	.556	1	.456
[Gender=2]	0 ^a	.	.	.	.	.	.
Pre-tests (Scale)	.153	.0139	.125	.180	120.808	1	.0001

Events: post-test Trials: 35

Model: (Intercept), Year Group, Location, Gender, pre-test

a. Set to zero because this parameter is redundant. b. Fixed at the displayed value.

Sig (significance probability) or the P value df numerator degree of freedom tells the number of predictors

Table 8.4 Parameter Estimates

Magnac (2006), defines the Logit function, as the reciprocal function to the sigmoid logistic function. The Logit function maps the interval [0, 1] into the real line and is written as:

$$\text{Logit}(P) = \ln\left(\frac{P}{(1-P)}\right)$$

Equation 15 Logit Function

Equation 15, outline the Logit function in terms of the binominal-linked function to the generalized liner model, were the value of P is the probability of a “yes”, and the value of 1-P is probability of a “no”. The logistic model is based on a linear relationship between the natural logarithm (ln) of the odds of an event and a numerical independent variable.

Equation 16 describes the Logit exponential function according to the laws of exponents. The Logit (p) is the \ln (odds of event); p is the proportion of event successes. To express p (the proportion of successes or risk of the event) in terms of L is equal to:

$$L = \ln\left(\frac{P}{1-P}\right) = \frac{e^L}{1 + e^L}$$

Equation 16 Logit Exponential Function

Hence the value of P (the probability of the event), according to the groups used for this experiment (Location, Gender, and Year Group), and the event variable (pre-test score) is illustrated in Equation 17:

$$P(\text{correct}) = \frac{e^{(\text{intercept} + \text{group}_y) + (\text{pre-test} * x)}}{1 + e^{(\text{intercept} + \text{group}_y) + (\text{pre-test} * x)}}$$

Equation 17 Logit Function (Real variables)

The probability that a student can get a better score in the different grouping factors (location, gender, year group), after the tutoring of Abdullah ATA-CITS can be predicted by implementing the Logit function (Equation 17).

As an example, a typical student from the year 5 group who achieves a pre-test score of 20 has a probability of 0.685 to have an improved post-test score after using Abdullah ATA-CITS. While a student in year 6 who achieved the same pre-test score (20) has less probability (i.e. 0.591) of improving their post-test score after using Abdullah ATA-CITS, as described in Table 8.5.

$P(\text{correct}) = \frac{e^{(-2.692 + 0.41) + (0.153 * 20)}}{1 + e^{(-2.692 + 0.41) + (0.153 * 20)}}$ $= 0.685$	Year 5
$P(\text{correct}) = \frac{e^{(-2.692 + 0) + (0.153 * 20)}}{1 + e^{(-2.692 + 0) + (0.153 * 20)}}$ $= 0.591$	Year 6
$P(\text{correct}) = \frac{e^{(-2.692 + 0.392) + (0.153 * 20)}}{1 + e^{(-2.692 + 0.392) + (0.153 * 20)}}$ $= 0.681$	Location 1 (UK)
$P(\text{correct}) = \frac{e^{(-2.692 + 0) + (0.153 * 20)}}{1 + e^{(-2.692 + 0) + (0.153 * 20)}}$ $= 0.591$	Location 2 (Jordan)

Table 8.5 Fitted Model Equation Result

Figure 8.3 and Figure 8.4 shows the predicted and observed post-test scores obtained by the students in the different location groups after using Abdullah ATA-CITS tutoring session.

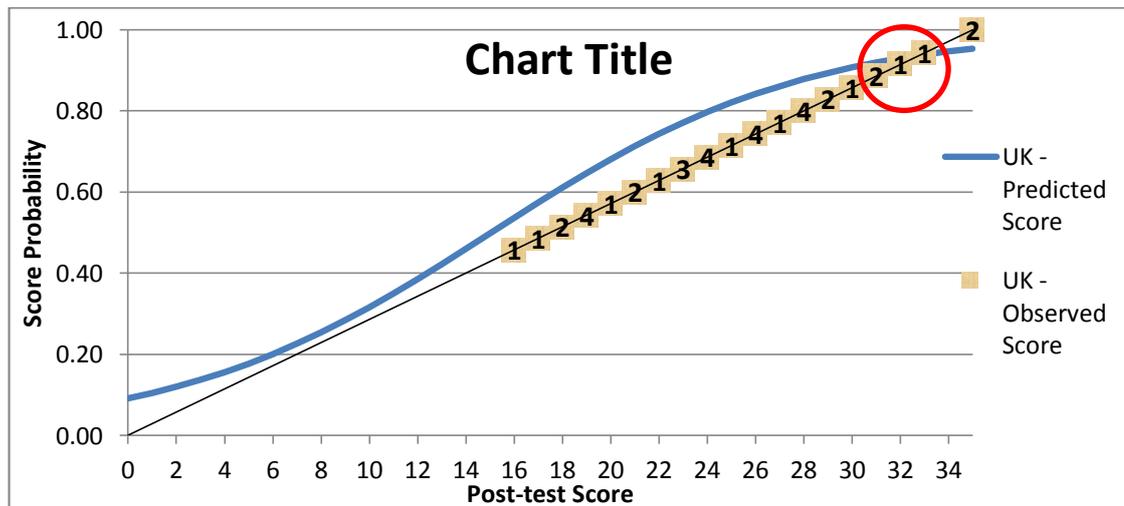


Figure 8.3 Location (UK) Logit Function

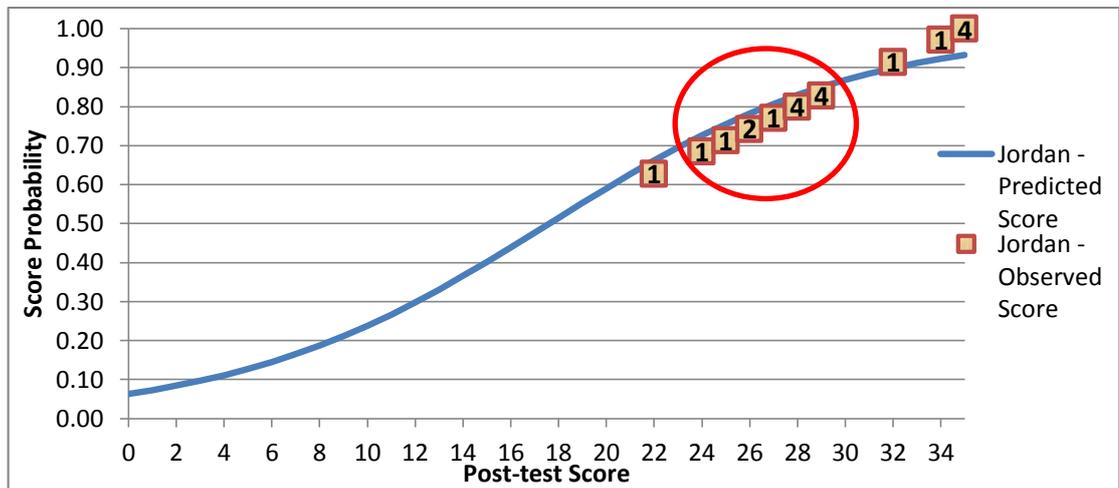


Figure 8.4 Location (Jordan) Logit Function

The scores which are obtained from the UK students (Figure 8.3) illustrate that when the scores are between the range of 30-33, the observed scores overlap the predicted scores. This means that in this range the students are more likely to score as predicted by the Logit function (i.e. there are two students have an observed scores of 31 with a probability of 88.6 while the predicted probability to have the same score was 92).

Figure 8.4 shows the probability of the score obtained after the tutoring from the students in Jordan. It can be deduced from the results that the higher scores from the predicted scores do not match the observed scores. However, for scores in the range of 22 - 32, the observed scores closely overlap the predicted scores. Figure 8.5 and Figure 8.6 illustrates the predicted and observed post-test scores obtained by the students in the two year groups (year 5 and 6) combined from both locations.

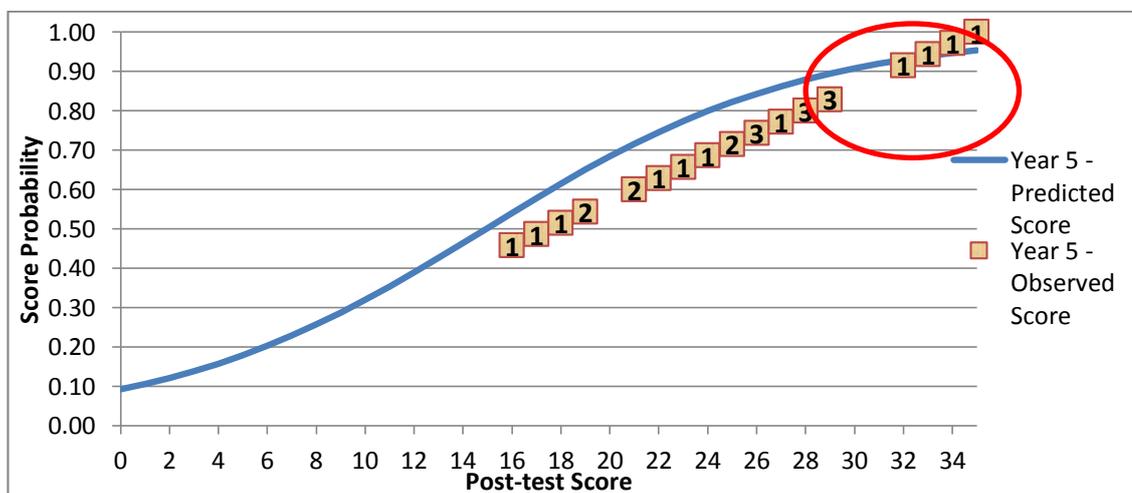


Figure 8.5 Year Group (5) Logit Function

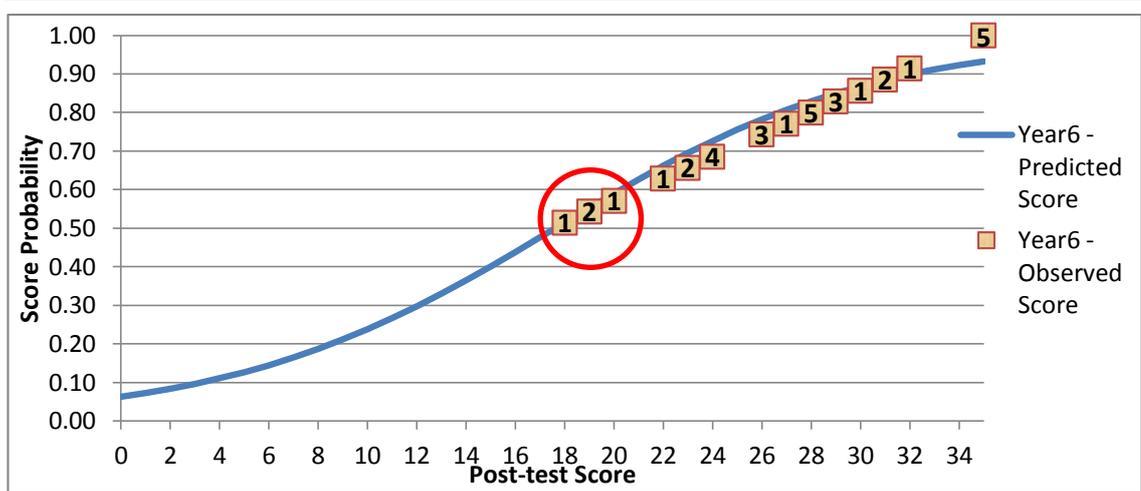


Figure 8.6 Year Group (6) Logit Function

In Figure 8.5 the estimated logit curve shows that the estimated probability of year 5 students in post-test score is almost the same as the predicted when the observed scores are between the ranges of 30 - 34. In Figure 8.6 the estimated logit curve shows that the estimated probability of year 6 student's post-test score overlaps the observed scores in two ranges, which are, the ranges of 16 to 20 and 30 to 34.

8.4.2.2. Answer classification - Results and Discussion

The answer classification metric/value (a variable stored in the log file), are used by Abdullah ATA-CITS to estimate the level of understanding of the user through the tutoring session. This metric will be utilised and analysed to answer hypothesis 1, through measuring the tutoring success. Abdullah ATA-CITS classifies an utterance from the user based on the strength of matching to the expected/scripted answer. Each utterance assign a value of 3 for the highly correct answer, a value of 2 for partially correct answers, a value of 1 for near miss answers, and a value of 0 for not an answer (illustrated in Table 8.6). The accumulative average of these values will be calculated and stored in the log file for each sub topic until the end of the tutoring session (as described in Table 8.7).

The utterance classifications are assigned in order to allow Abdullah ATA-CITS to reply with responses, which were appropriate and related to the user's knowledge/understanding level.

Answers Classification	Score Recorded by Abdullah ATA-CITS
Highly correct	3
Partially correct	2
Near miss answers	1
Not an answer	0

Table 8.6 Abdullah CITS Score Recorded

Table 8.7 illustrates the accumulative average of the answer classifications from the log file of the participant/student discussions with Abdullah ATA-CITS after each tutoring session. Table 8.7 illustrates the observed value for the accumulative average value for each branch.

Brach Sub Topic	Branch 1 (To know your God)	Branch 2 (To know your Prophet)	Branch 3 (To know your Religion)	Best Average Score
	Cumulative Average	Cumulative Average	Cumulative Average	Cumulative Average
1	2.90	2.53	2.38	3.00
2	5.10	4.75	3.88	6.00
3	7.20	7.22	6.44	9.00
4	9.30	8.78	8.00	12.00
5	11.50	11.25	9.44	15.00
6	13.70	13.47	10.81	18.00
7	15.90	15.97	12.13	21.00
8	17.80	17.84	13.75	24.00
9	19.60	20.06	15.38	27.00
10	21.30	22.53	17.00	30.00
11	23.20	24.28	19.44	33.00
12	24.90	26.69	20.88	36.00
13	26.80	29.19	22.31	39.00
14	28.30	31.19	23.50	42.00
15	30.50	33.66	25.00	45.00
16		35.38	26.63	48.00
17		37.81	27.88	51.00
18		39.53	30.25	54.00
19		42.03	32.06	57.00
20		43.69	34.38	60.00
21		45.34	37.06	63.00
22		47.75	39.38	66.00
23			40.38	69.00
24			41.88	72.00
25			43.38	75.00
26			45.13	78.00
27			46.56	81.00
28			48.94	84.00
	67.78%	72.35%	58.26%	

Table 8.7 Branches Cumulative Average

The accumulative average value will be compare to the highest/best value, which can be obtained from each tutoring branch, which is based on the number of subtopics in each branch. As an example the first branch covers 15 subtopics and assuming that student got the highly corrected answer for each subtopic, that will gave a value of 45 as the best accumulative average for first branch at the end of tutorial (illustrated in Table 8.8).

Branch	Number of sub topics	Highest value that can be obtained in branch
1	15	45
2	22	66
3	28	84

Table 8.8 highest value for each tutoring branch

It can be seen from Table 8.7 and Figure 8.7 that the third branch (i.e. to know your religion), has the lowest value of accumulative average among all the tutoring branches. Comparing the best accumulative average for each branch against the observed values gave percentages of (67.78%, 72.35%, and 58.26% for the first second and third branches respectively) as illustrated in Figure 8.7.

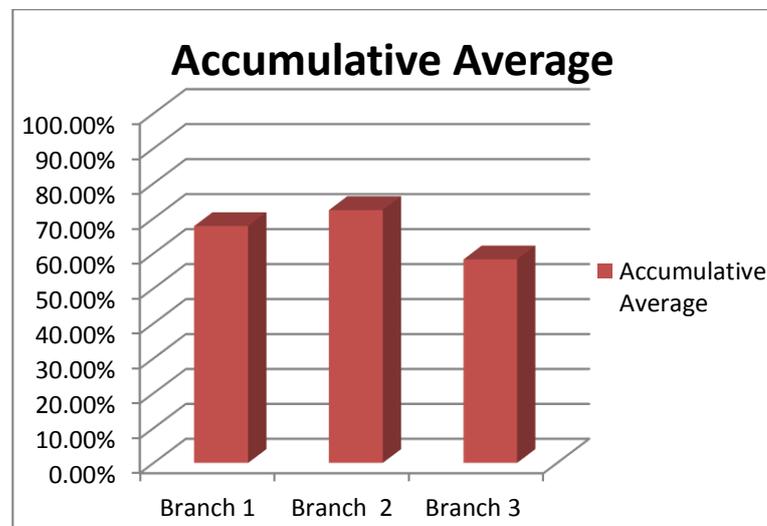


Figure 8.7 Accumulative Average Chart

The results illustrated in Table 8.7 indicate that the students scored the highest accumulative average in the second branch (to know your Prophet) of the tutoring topics, which means that the student demonstrated more understanding in this fundamental/branch compared to the other branches. The lowest accumulative average was found in the third branch (to know your religion); this indicates that the students found this branch/topic the most difficult. These results are as expected as the type of questions assigned for the branch “to know your Prophet” are much easier in comparison to the questions in the third branches “to know your religion”.

8.4.2.3. Completion Time - Results and Discussion

Completion time or dialogue time is an important metric for most dialogue systems, and can be measured in terms of how much time taken, for a given task takes to complete (Forbes-Riley and Litman, 2011) .

In Abdullah ATA-CITS a completion time is defined as completion time of a conversational tutorial for one of the three branches (to know you're God, his messenger, and the religion of Islam), which were randomly assigned to the user. The completion time can be used to measure the understanding and level of knowledge of the user/student, which can be used to measure the tutoring success of Abdullah ATA-CITS. The average time per interaction (ATPI) for a given branch will be calculated using the following equation (Equation 18).

$$ATPI = \frac{\text{Total durations for all dialogues in Branch (X)}}{\text{Number of utterances for all dialogues in Branch (X)}}$$

Equation 18 Abdullah ATA-CITS average time per interaction (ATPI)

The value of ATPI can be used as a baseline to detect/measure the user/student's level of understanding and level of knowledge of the tutoring content. The values above the ATPI indicate that the student is struggling and has a low level of understanding and values below ATPI indicate that the student is coping well and has a high level of understanding as detailed in (Chapter 6 section 6.5). Table 8.9, shows the number of students who completed each of the three fundamental principles, and the ATPI for each branch based on their discussion.

Branch Number	Number OF Students	Number OF Subtopic	Eq4 (in Minutes)
Branch 1	10	15	1.70
Branch 2	32	22	1.25
Branch 3	16	28	1.89

Table 8.9 Tutoring Average Time for a Given Branch

The results show that the highest ATPI (1.89) was for the third branch “to know your religion”, while the lowest ATPI (1.25) was for the second branch “to know your prophet”. However, these values indicate that the students required more time in order to understand the questions assigned for the third branch than the second branch. These findings coincide with the earlier findings of the answer classifications in the previous section.

Figure 8.8; show the ATPI of the student from branch two. It can be seen from the results that the ATPI value for the majority of the students was close to the baseline APTI value. This indicates that the student found the tutoring content of the second branch more understandable as the APTI was very close to the baseline.

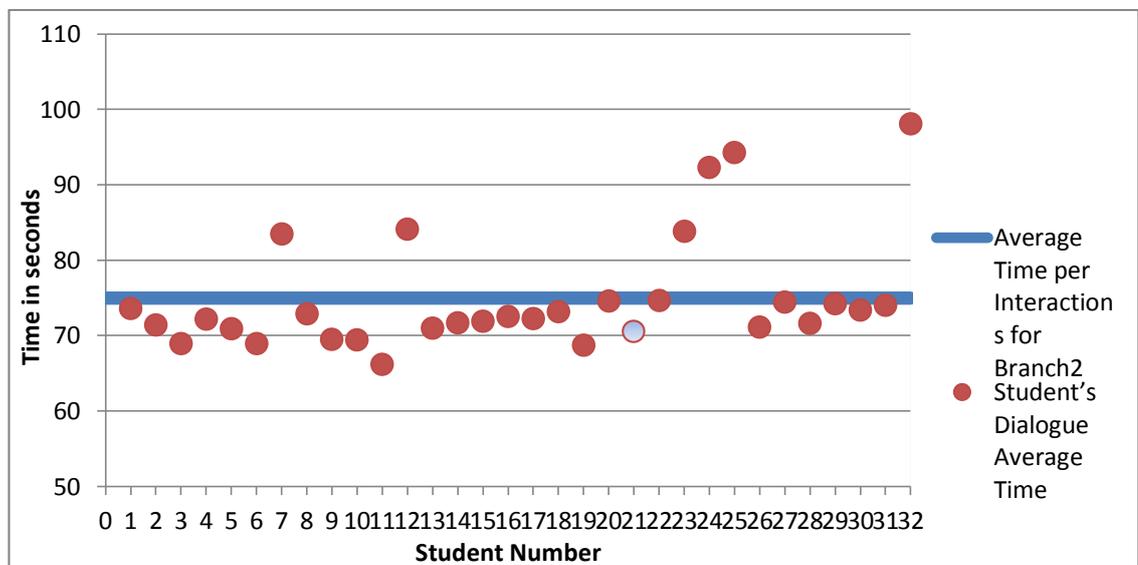


Figure 8.8 The distance between ATPI for branch 2

In branch1 (to know your God), the average results of time per interaction for the students is widely distributed from the baseline ATPI (Figure 8.9). This indicates that the students were struggling with the tutoring content in this branch, and found difficulties in answering the questions asked by Abdullah ATA-CITS. It also appears that the students, who could not answer the questions during the tutoring session, simply replied quickly without reading the full question, by typing an utterance like “I don’t know or I don’t understand”.

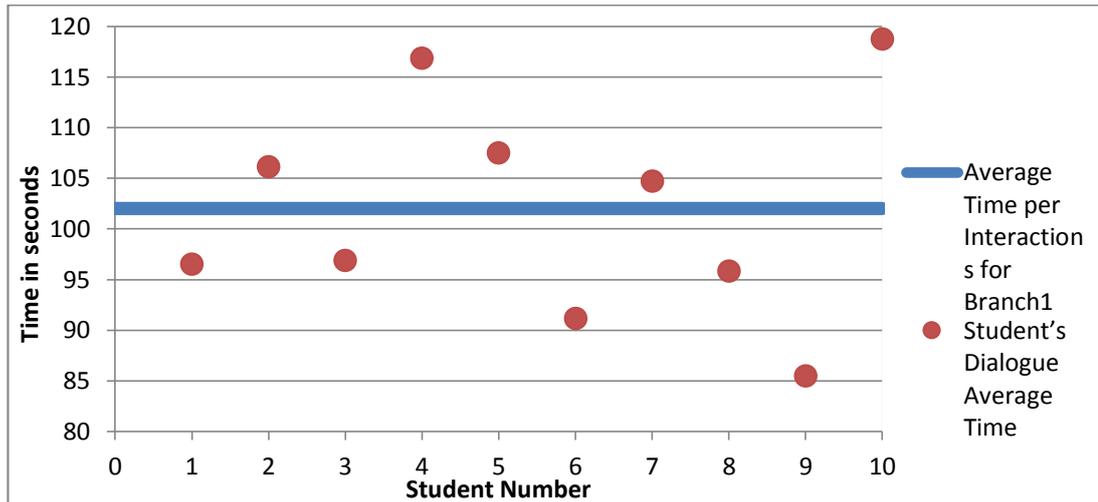


Figure 8.9 The distance between ATPI for branch 1

In branch3 (to know your religion), the majority of the students have an average results time per dialogue above the baseline ATPI (Figure 8.10), and this indicates that the students are not understating the tutoring content, and founding difficulties with the questions asked by Abdullah ATA-CITS.

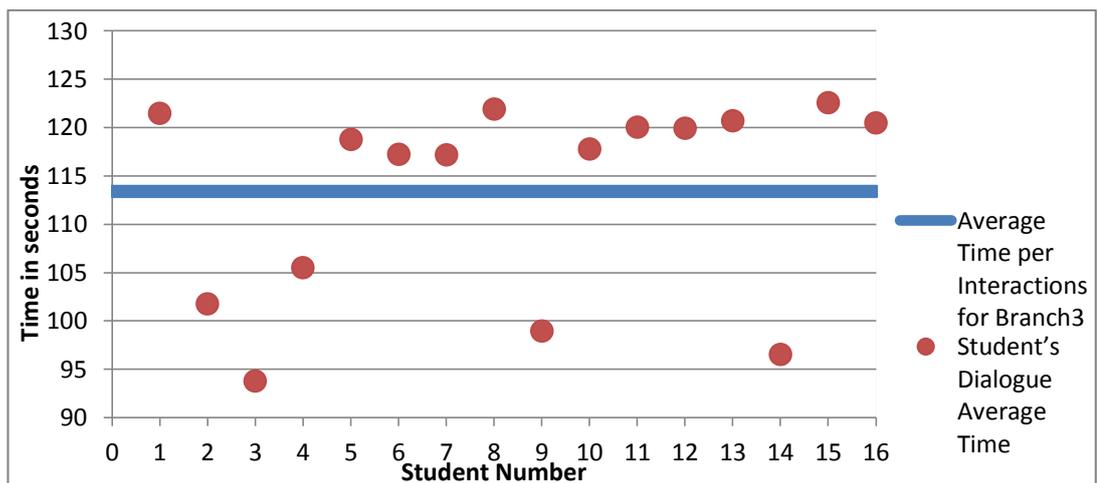


Figure 8.10 The distance between ATPI for branch 3

The results of the ATPI analysis shown in the previous figures (Figure 8.8, Figure 8.9, and Figure 8.10) indicate that the students found branch 2 (to know your prophet) most understandable and coped easily with the tutoring content. The reason behind this could be that the content covered by this branch is taught to children by the parents in early ages (prior to school).

While in branch three (to know your religion), which covers more advanced topics and questions which is taught after the children have fully understood the first two fundamental principles. This could be the reason behind why the students exhibited lower levels of understanding of the tutoring content and took longer to answer the questions in this branch.

8.4.2.4. Quality of tutorial (Questionnaire) - Results and Discussion

The quality of tutoring was measured through the user questionnaire, which was designed to answer hypothesis H1 (Figure 8.1). Once the Abdullah ATA-CITS tutoring session ended the students were presented with a questionnaire which aimed to measure subjective metrics related to the tutoring session including, whether they were learning from the tutoring session with Abdullah ATA-CITS or not. Tutoring quality was examined through a statement from the questionnaire (Questionnaire question 2, which illustrated in Figure 8.1 GQM Model for Abdullah CITS Evaluation), which the students were asked to rate which was “There is too much to learn in one tutorial!” as illustrated in section 8.2.3.

Table 8.10, shows that the majority of students are happy about the information content that was given by Abdullah ATA-CITS with a percentage of 44.8%, 41.4% stated they have a neutral feeling about the learning content in the tutoring session and only 13.8% of students were not happy with amount of information in the tutoring session. It can be seen from (Figure 8.11), that the majority of students are quite happy with the amount, and the quality of information given in the tutoring session.

			Location		Total
			UK	Jordan	
Q2: There is too much to learn in one tutorial.	Sad	Count	5	3	8
		% within Q2: There is too much to learn in one tutorial.	62.5%	37.5%	100.0%
		% of Total	8.6%	5.2%	13.8%
	Normal	Count	11	13	24
		% within Q2: There is too much to learn in one tutorial.	45.8%	54.2%	100.0%
		% of Total	19.0%	22.4%	41.4%
	Happy	Count	22	4	26
		% within Q2: There is too much to learn in one tutorial.	84.8%	15.4%	100.0%
		% of Total	37.9%	6.9%	44.8%
Total	Count	38	20	58	
	% within Q2: There is too much to learn in one tutorial.	65.5%	34.5%	100.0%	
	% of Total	65.5%	34.5%	100.0%	

Table 8.10 Crosstab * Location – Q2

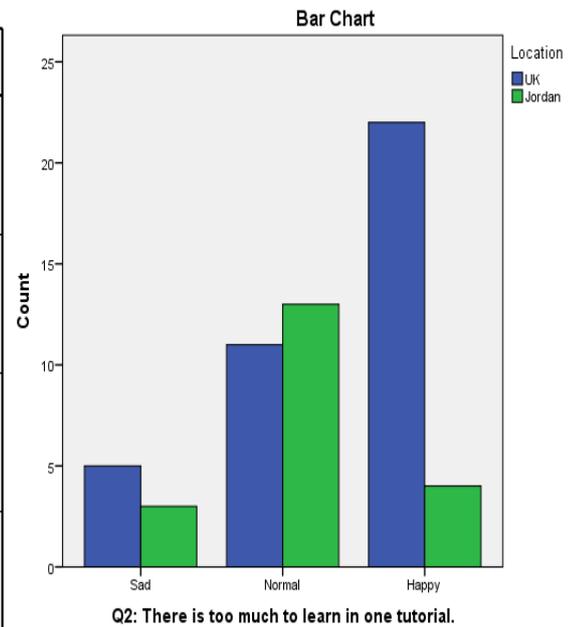


Figure 8.11 Q2 Between the Locations Chart

Table 8.11 indicate that there is a strong statistically significant relationship (p value = 0.015 which is less than .05), between difference locations (UK and Jordan).

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.346 ^a	2	.015
Likelihood Ratio	8.712	2	.013
Linear-by-Linear Association	4.151	1	.042
N of Valid Cases	58		

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 2.76.

Table 8.11 Chi-Square Test * Location – Q2

The results illustrated, that the UK students are much happier than the Jordanian students rating this question. It can be determined from the figure (Figure 8.11) that the UK students were more satisfied than the Jordanian student during the tutoring session. These results indicate that the student found the delivery of the tutoring content appropriate and not overwhelming. This is a positive result for the Abdullah ATA-CITS as it indicates that the tutoring topics/content is structured in an appropriate way for the target age group.

In accordance to the year group (year 5 and 6), it can be found that there is a significant relationship (p value = 0.033 which is less than .05) between the year groups as shown in (Table 8.12).

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.837 ^a	2	.033
Likelihood Ratio	7.353	2	.025
Linear-by-Linear Association	3.593	1	.058
N of Valid Cases	58		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 3.59.

Table 8.12 Chi-Square Test * Year Group – Q2

Table 8.13 illustrates that 61.5% of year six students rating tutoring contents happy, in comparison with year five who rate 38.5%. In total eight of respondents from the year five and year six to questioner question 2 indicating sad. 87.5% of these respondents were from the year five and 12.5% were from year six. In general and as shown in Figure 8.12, year six students are more likely to understand the content of the tutorial than year five, due to their level of pre-knowledge being higher than the year 5 group.

		Year Group		Total	
		Year Five	Year Six		
Q2: There is too much to learn in one tutorial.	Sad	Count	7	1	8
		% within Q2: There is too much to learn in one tutorial.	87.5%	12.5%	100.0%
		% of Total	12.1%	1.7%	13.8%
	Normal	Count	9	15	24
		% within Q2: There is too much to learn in one tutorial.	37.5%	62.5%	100.0%
		% of Total	15.5%	25.9%	41.4%
	Happy	Count	10	16	26
		% within Q2: There is too much to learn in one tutorial.	38.5%	61.5%	100.0%
		% of Total	17.2%	27.6%	44.8%
Total	Count	26	32	58	
	% within Q2: There is too much to learn in one tutorial.	44.8%	55.2%	100.0%	
	% of Total	44.8%	55.2%	100.0%	

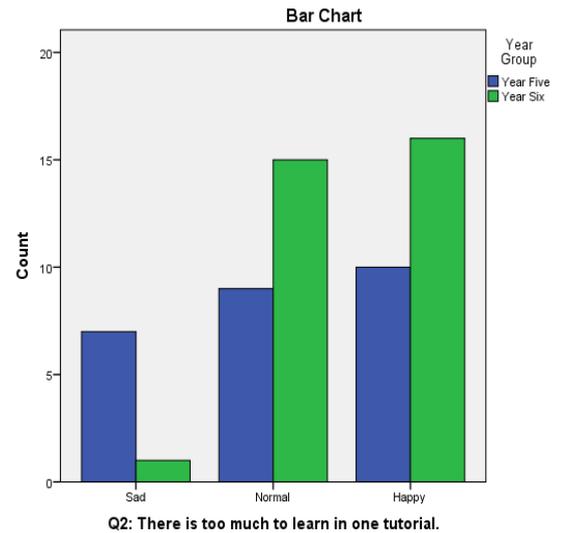


Figure 8.12 Q2 Between the Year Group

Table 8.13 Crosstab * Year Group – Q2

Table 8.14, shows that there is not a significant relationship (p value = 0.721 which is greater than .05) between the gender, and the students rating this question.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.654 ^a	2	.721
Likelihood Ratio	.659	2	.719
Linear-by-Linear Association	.553	1	.457
N of Valid Cases	58		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 4.00.

Table 8.14 Chi-Square Test * Gender – Q2

Table 8.15 and Figure 8.13 illustrates that there are approximately the same number of students from both gender in each category rating this question.

Crosstab

			Gender		Total
			Male	Female	
Q2: There is too much to learn in one tutorial.	Sad	Count	3	5	8
		% within Q2: There is too much to learn in one tutorial.	37.5%	62.5%	100.0%
		% of Total	5.2%	8.6%	13.8%
	Normal	Count	12	12	24
		% within Q2: There is too much to learn in one tutorial.	50.0%	50.0%	100.0%
		% of Total	20.7%	20.7%	41.4%
	Happy	Count	14	12	26
		% within Q2: There is too much to learn in one tutorial.	53.8%	46.2%	100.0%
		% of Total	24.1%	20.7%	44.8%
Total	Count	29	29	58	
	% within Q2: There is too much to learn in one tutorial.	50.0%	50.0%	100.0%	
	% of Total	50.0%	50.0%	100.0%	

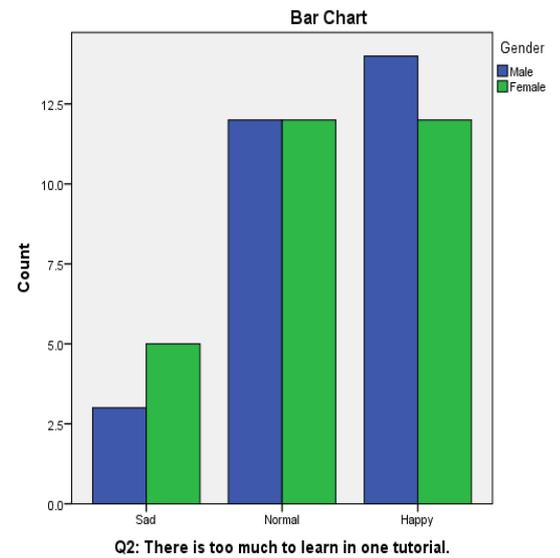


Figure 8.13 Q2 Between Gender

Table 8.15 Crosstab * Gender – Q2

8.4.2.5. Quality of tutorial (Questionnaire) Conclusion

Following the results described in section (8.4.2.4), students in general found there are too much to learn from Abdullah ATA-CITS. 84.6% of the students in UK found that there are too much to learn and take on board in comparison with the students in Jordan (15.4%). This is understandable as the Jordanian students are being taught Islamic subjects in the curriculum so they will be more accustomed to the tutoring content in comparison to the UK students. Students in year five in both UK and Jordan found that there was too much to learn in comparison with year six students. However, there was no difference between students rating these questions according to their gender group.

8.4.2.6. Tutoring content (Questionnaire) - Results and Discussion

The Tutoring content was examined by asking the students, to rank the statement “Abdullah the tutor overloads you with information!” which is related to the content of the tutoring (illustrated as questionnaire question 7 “Q7”, in Figure 8.1 GQM Model for Abdullah CITS Evaluation) . The results in Table 8.16 demonstrate that the majority of students from the whole sample have a neutral feeling (58.6%), a quarter of the students (25.9%) are happy, and (15.5%) of the students felt not happy when rating this statement. Figure 8.14 also illustrates that there is a strong difference between the UK students who rate this question neutral (70.6%), and the Jordanian students who rate it neutral (29.4%).

			Location		Total
			UK	Jordan	
Q7: Abdullah the Tutor overloads you with information.	Sad	Count	8	1	9
		% within Q7: Abdullah the Tutor overloads you with information.	88.9%	11.1%	100.0%
		% of Total	13.8%	1.7%	15.5%
	Normal	Count	24	10	34
		% within Q7: Abdullah the Tutor overloads you with information.	70.6%	29.4%	100.0%
		% of Total	41.4%	17.2%	58.6%
	Happy	Count	6	9	15
		% within Q7: Abdullah the Tutor overloads you with information.	40.0%	60.0%	100.0%
		% of Total	10.3%	15.5%	25.9%
Total	Count	38	20	58	
	% within Q7: Abdullah the Tutor overloads you with information.	65.5%	34.5%	100.0%	
	% of Total	65.5%	34.5%	100.0%	

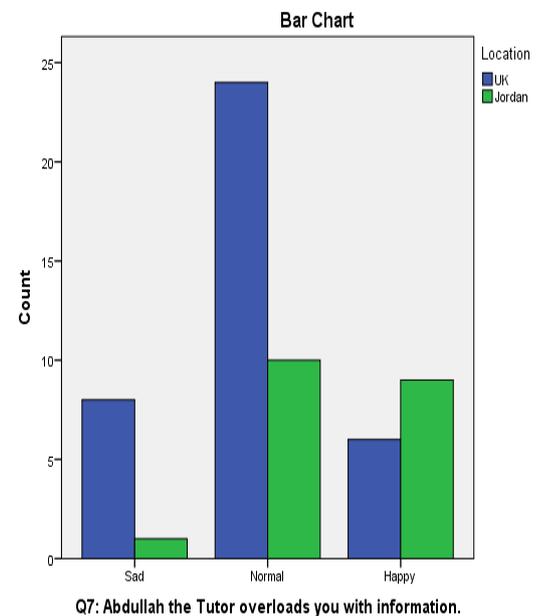


Figure 8.14 Q7 Between the Location Chart

Table 8.16 Crosstab * Location - Q7

A Chi-square test Table 8.17 shows that there is a strong statistically significant relationship between the locations when the students rate this question (p value is less than .05).

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.886 ^a	2	.032
Likelihood Ratio	7.062	2	.029
Linear-by-Linear Association	6.545	1	.011
N of Valid Cases	58		

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 3.10.

Table 8.17 Chi-Square Test * Location - Q7

Table 8.18 indicate that there are a significant relationship (p value = 0.025) between the year group (year 5 and 6), for the students rating this question.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.385 ^a	2	.025
Likelihood Ratio	7.617	2	.022
Linear-by-Linear Association	6.768	1	.009
N of Valid Cases	58		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 4.03.

Table 8.18 Chi-Square Test * Year Group – Q7

Figure 8.15, shows that the students in year five are happier than the students in year six, with 26.7% happy in year 6 in comparison with year 5, which was 73.3%. Furthermore the crosstab table (Table 8.19), illustrates that the students in year six have more neutral feeling than year five with a percentages of (61.8%, and 38.2% respectively).

Only two students (22.2%), from year five found that Abdullah ATA-CITS did not overload them with information during the tutoring session, in comparison with year six with (77.8%).

Crosstab

			Year Group		Total
			Year Five	Year Six	
Q7: Abdullah the Tutor overloads you with information.	Sad	Count	2	7	9
		% within Q7: Abdullah the Tutor overloads you with information.	22.2%	77.8%	100.0%
		% of Total	3.4%	12.1%	15.5%
	Normal	Count	13	21	34
		% within Q7: Abdullah the Tutor overloads you with information.	38.2%	61.8%	100.0%
		% of Total	22.4%	36.2%	58.6%
	Happy	Count	11	4	15
		% within Q7: Abdullah the Tutor overloads you with information.	73.3%	26.7%	100.0%
		% of Total	19.0%	6.9%	25.9%
Total	Count	26	32	58	
	% within Q7: Abdullah the Tutor overloads you with information.	44.8%	55.2%	100.0%	
	% of Total	44.8%	55.2%	100.0%	

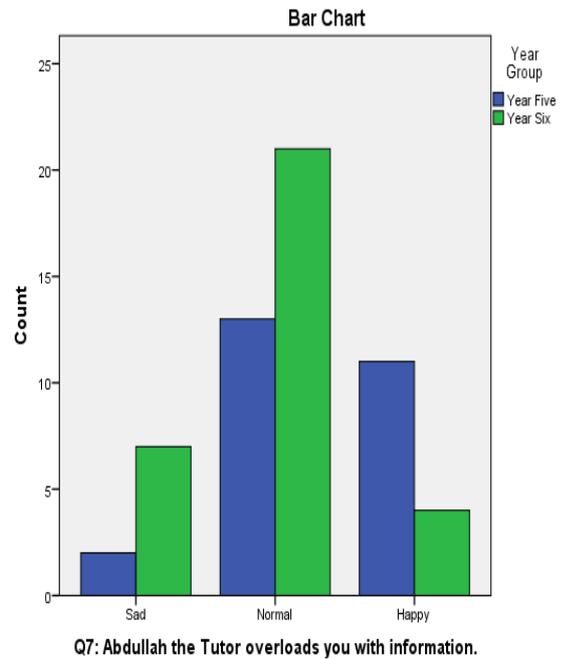


Table 8.19 Crosstab * Year Group -Q7

Figure 8.15 Q7 Between the Year Group

Table 8.20 indicates that there is not a significant relationship (p value = 0.449 which is greater than .05) between the gender and the students rating this questions.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.600 ^a	2	.449
Likelihood Ratio	1.623	2	.444
Linear-by-Linear Association	1.513	1	.219
N of Valid Cases	58		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 4.50.

Table 8.20 Chi-Square Test * Gender - Q7

Table 8.21 and Figure 8.16 shows that there is approximately the same responses from both genders when the students rating this question.

		Gender		Total	
		Male	Female		
Q7: Abdullah the Tutor overloads you with information.	Sad	Count	3	6	9
		% within Q7: Abdullah the Tutor overloads you with information.	33.3%	66.7%	100.0%
		% of Total	5.2%	10.3%	15.5%
	Normal	Count	17	17	34
		% within Q7: Abdullah the Tutor overloads you with information.	50.0%	50.0%	100.0%
		% of Total	29.3%	29.3%	58.6%
	Happy	Count	9	6	15
		% within Q7: Abdullah the Tutor overloads you with information.	60.0%	40.0%	100.0%
		% of Total	15.5%	10.3%	25.9%
Total	Count	29	29	58	
	% within Q7: Abdullah the Tutor overloads you with information.	50.0%	50.0%	100.0%	
	% of Total	50.0%	50.0%	100.0%	

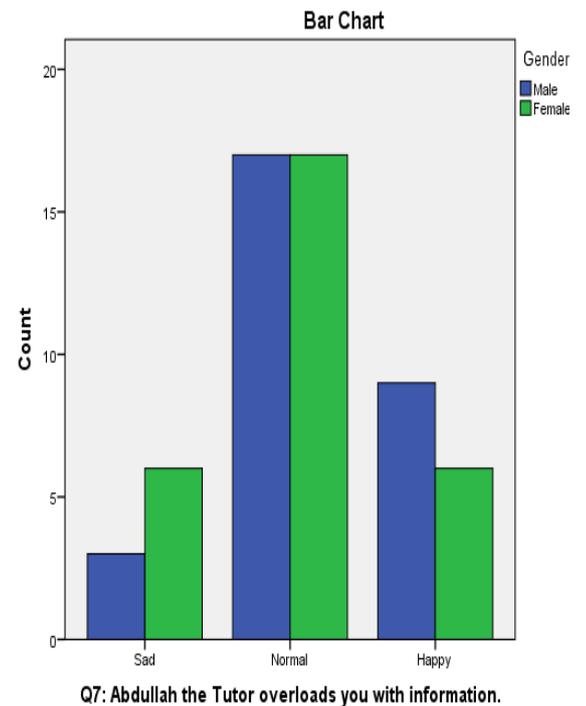


Table 8.21 Crosstab * Gender - Q7

Figure 8.16 Q7 Between the Gender Chart

8.4.2.7. Tutoring content (Questionnaire – Question 1) Conclusion

The results highlight that the students in general found Abdullah ATA-CITS was not overloading them with information. Students in UK showed a neutral feeling about the level of information that given to them, while students in year five found there are too much to learn from Abdullah ATA-CITS in comparison with year six students.

However, it can be concluded that the year five UK students found that Abdullah ATA-CITS overloads them with information than year six Jordanian students.

8.4.3. Experiment 1 (Tutoring Success) Conclusion

As stated in (section8.3), the experimental results evaluated five metrics related to hypothesis H1, as follows:

- Pre and Post Test
- Answers classification
- Completion Time
- Quality of tutorial
- Tutoring content

As illustrated in the section (8.2.2 Designing of Evaluation Metrics), five metrics were used to answer the three questions been asked in (Figure 8.1 GQM Model for Abdullah CITS Evaluation).

It can be summarized from the results and analysis for these metrics, that the results are positive and highlight that Abdullah ATA-CITS is successful in tutoring. The results indicate that there is a strongly significant between the pre-test and post-test score (there are a significant in learning gain), after the students taught using Abdullah ATA-CITS (section 8.4.2.1).

The results of the answer classification showed that the accumulative average score of the students in each tutorial branch was satisfactory. Furthermore, this metric was a clear indication to the level of understanding for each student in each of the tutoring branch, as the more difficult topics/fundamental had lower accumulative average scores than the easier/less-complex ones.

The results of the completion time showed that the majority of the students were able to complete the tutorial questions in a satisfactory time. These results also indicate that the average time per interaction (ATPI) equation used to measure and indicate tutoring success is a good method to gauge the understanding and level of knowledge of the students. The quality of tutorial and tutoring content was measured through the user questionnaire. The results found that the majority of the students were happy with the amount and content of information given to them by Abdullah ATA-CITS. This is also an indicator that the tutoring content is structured well for the target age group. Therefore, the main hypothesis (The success of students in a particular tutoring method is indicative of participant's knowledge improvement in the taught subject.) is supported.

8.4.4. Experiment Two: Adaptability to Student Knowledge Level

Experiment 2 is conducted to test the second hypothesis H2 (It is possible to adapt to the student's knowledge level from a tutoring discourse with an intelligent tutoring conversational agent), which is defined in section 8.2.1. This experiment is based on the log file that records the dialogue between the user and the system, as well as the results of the questionnaire conducted after the tutoring session. In experiment 2 a number of metrics (Table 8.22) are used to test H2.

Metric to be Evaluated	Mode of Evaluation	Subjective / Objective	Hypothesis tested
Answers classification	Log file	Objective Metric	Hypotheses 1 and 2
Questions classification	Log file	Objective Metric	Hypotheses 2
Quality of tutorial	Questionnaire	Subjective Metric	Hypotheses 2
Quality of teaching	Questionnaire	Subjective Metric	Hypotheses 2

Table 8.22 Experiment two Metrics

8.4.5. Experiment 2 Results and Discussion

This section will present the collected results of all four metrics (Table 8.22) which were captured during the tutoring sessions and extracted from part of the student's questionnaire completed after the Abdullah ATA-CITS tutoring session.

8.4.5.1. Answers Classification based on Year, and Locations groups

This experiment is conducted to inspect whether the accumulative average score of the students answers would differ between locations and year groups of the students. Answers are classified into highly correct, partially correct, and near miss answers as discussed in (chapter 5, section 5.3.2.2.3).

As an example, a match of 80% between utterance and preferred answers in the tutorial knowledge base is classified as a highly correct answer and Abdullah ATA-CITS will record a value of three as the score for this question.

A match of 50% is classified as partially correct answer and Abdullah ATA-CITS will record a value of two. A match of 30% is recorded as a low near miss answer and Abdullah ATA-CITS will record a value of one.

8.4.5.1.1. Answers Classification (Year Groups) Results and Discussion

Table 8.23 shows the average score of questions answered by the students based on the year groups (year 5, and year 6). This average/mean score describes the accumulative average of all students who answered the tutoring questions in year five and year 6.

The average of each sub topic within each tutoring branch is calculated. These averages are then utilised to calculate the accumulative average of each branch. Figure 8.17 shows that year six have more correct answers than year five students.

	Year Group	N	Mean	Std. Deviation	Std. Error Mean
Groups	Year Five	26	1.04	.824	.162
	Year Six	32	1.97	.897	.159

Table 8.23 Year Groups Statistics
Answers Classification

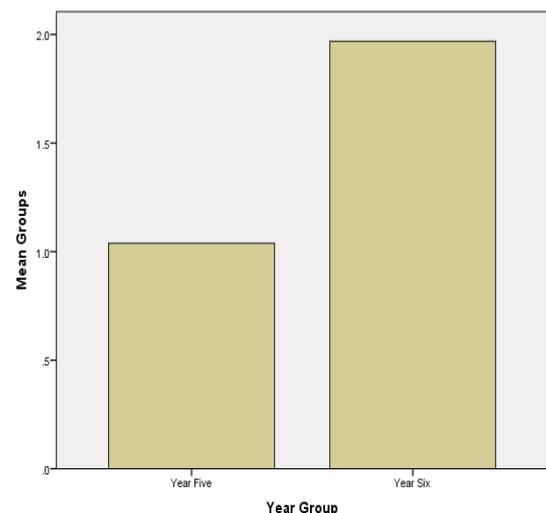


Figure 8.17 Mean Year Groups Answers Classification Chart

Table 8.24 shows a strongly significant difference (p value = 0.001) between year groups. This is an indication of the level of knowledge in the taught subject for year 6 student in comparison to year 5 students.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Groups	Equal variances assumed	1.119	.295	-4.072	56	.0001	-.930	.228	-1.388	-.473
	Equal variances not assumed			-4.109	55.126	.0001	-.930	.226	-1.384	-.477

Table 8.24 Year Groups Independent Sample Test

The percentages of the students that have more corrected answers during the tutoring session (i.e. Abdullah ATA-CITS session), is an indication that the students are more understanding the tutoring content in the tutoring session (Smith et al., 2009).

8.4.5.1.2. Answers Classification (Location) Results and Discussion

Table 8.25 shows the average score of the questions answered by the students based on the location groups (Jordan, and UK). This average/mean score describes the accumulative average of all students who answered the tutoring questions in Jordan and UK. Figure 8.18 shows that the students in Jordan have better understanding of the questions asked by Abdullah ATA-CITS than the UK students, as the results show a higher accumulative average score for the Jordanian students.

Location		N	Mean	Std. Deviation	Std. Error Mean
Groups	UK	38	1.16	.789	.128
	Jordan	20	2.30	.865	.193

Table 8.25 Location Statistics Answers Classification

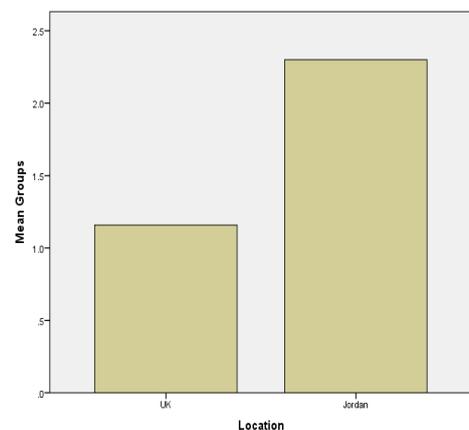


Figure 8.18 Mean Location Answers Classification Chart

Table 8.26 shows a strongly significant difference (p value = 0.00005) between different location groups (UK and Jordan).

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Groups	Equal variances assumed	1.411	.240	-5.069	56	.000005	-1.142	.225	-1.593	-.691
	Equal variances not assumed			-4.926	35.792	.000019	-1.142	.232	-1.612	-.672

Table 8.26 Location Independent Sample Test

The significant difference between the Jordanian and UK student's accumulative average scores could be because, the Jordanian students are taught Islamic topics in the home and in early stages of their education compared with the UK students who might taught Islamic topics only in the home.

8.4.5.1.3. Answers Classification Conclusion

As stated in the experiment 2 (answers classification), the results from this experiment indicated that the students in Jordan show more understanding of the tutoring content than the students in UK. Since the Jordanian students have an accumulative average of 2.3 (Table 8.25) out of three (a score of three indicates the highly corrected answers). The accumulative average shows that the Jordanian student's answers in general are in the range of two to three (the medium correct answer "2", and the highly corrected answer "3").

Also year six students have an average of 1.97 which is very close to two (the medium answers), this indicate that year six show more understanding of the tutoring content than year five who had a mean of 1.04 as show in table (Table 8.23).

8.4.5.2. Questions Classification

Tutorial questions are organized in the Tutorial Knowledge Base as questions with answers in a default style (A normal basic question which designed to suit different levels of student's knowledge), or as questions with answers in detailed style (A type of questions for the student's with low level of knowledge). Abdullah ATA-CITS will record a value of one for default questions, and a value of zero for detailed style questions. Abdullah ATA-CITS will be recorded these values in the log file to know the level of questions, which have been asked during the tutoring session.

8.4.5.2.1. Year Groups Results and Discussion

The average results by the year groups can be measured by counting the accumulative average of the students who have been delivered questions during the tutorial from Abdullah ATA-CITS in either the default or detailed style. Figure 8.19 , shows that year six are more likely to understand the questions asked by Abdullah ATA-CITS because the results show they were delivered more default question than year five. The results indicate that the students in year 6 have an average of (0.75), in comparison to the students in year 5 average (0.35) as shown in Table 8.27.

Year Group	N	Mean	Std. Deviation	Std. Error Mean
Groups Year Five	26	.35	.485	.095
Year Six	32	.75	.440	.078

Table 8.27 Year Groups Statistics Questions Classification

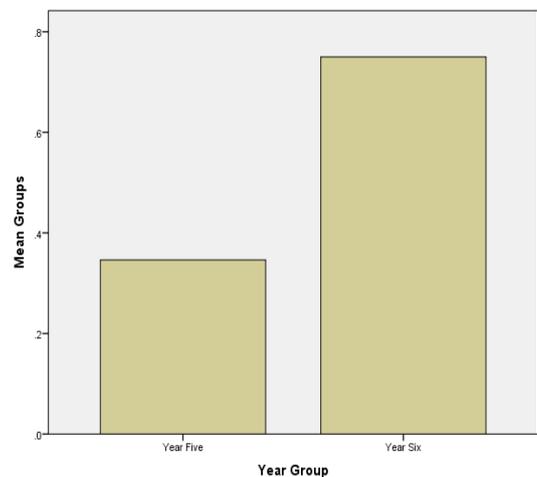


Figure 8.19 Mean Year Groups Questions Classification Chart

Table 8.28, also illustrate that there is a strong statistically significant difference (p value = 0.002) between year groups. This result could be because the students in year six are starting to build and practice the Muslim duties such as praying and therefore have more knowledge about the tutoring content compared to year 5 students.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Groups	Equal variances assumed	2.355	.130	-3.320	56	.002	-.404	.122	-.648	-.160
	Equal variances not assumed			-3.286	51.151	.002	-.404	.123	-.651	-.157

Table 8.28 Year Groups Independent Sample Test Questions Classification

8.4.5.2.2. Location Results and Discussion

Table 8.29 shows the average results by the location groups (UK and Jordan), the mean describes the accumulative average score of the students who have been asked questions by Abdullah ATA-CITS either in the default or in detailed style. Figure 8.20 shows that it is almost the same average results between the students who are taught using Abdullah ATA-CITS in UK or in Jordan.

Location	N	Mean	Std. Deviation	Std. Error Mean
Groups UK	38	.58	.500	.081
Jordan	20	.55	.510	.114

Table 8.29 Locations Groups Statistics Questions Classification

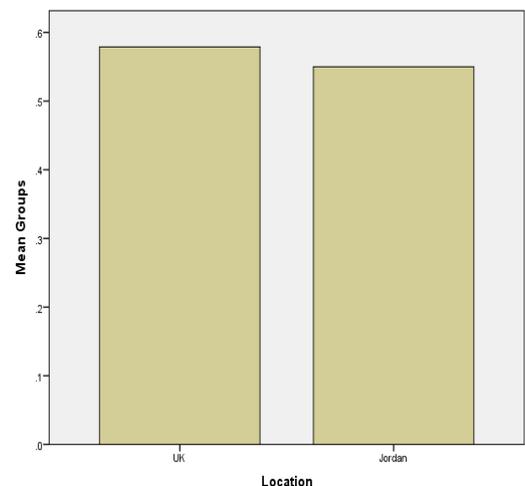


Figure 8.20 Mean Locations Groups Questions Classification Chart

Table 8.30 shows that there is not a significant relationship (p value >0.05) between the location groups (UK and Jordan).

This means that the students in both locations had the almost the same differing levels of knowledge between them (i.e. both student's groups have default and detailed style questions).

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Groups	Equal variances assumed	.146	.704	.208	56	.836	.029	.139	-.250	.308
	Equal variances not assumed			.207	38.078	.837	.029	.140	-.255	.312

Table 8.30 Locations Groups Independent Sample Test Questions Classification

8.4.5.2.3. Questions Classification Conclusion

As stated in experiment 2, year six students are found to have been asked more default level questions by Abdullah ATA-CITS (mean value of 0.75), than year five students (mean value of 0.35). The results revealed that the majority of year five student were asked the detailed questions by Abdullah ATA-CITS. This was due to the system measuring their level of knowledge and determining that their level of knowledge was low, thus they were presented with more detailed questions to help them answer the tutorial questions (illustrated in Table 8.27). More detailed questions are presented when the students exhibit misunderstandings of the topics during the tutoring (Bazerman, 2011). From these results, it can also be seen that the Jordanian students demonstrated more understanding of the tutoring topics presented by Abdullah ATA-CITS compared to the UK students. Again, this results stems from the Jordanian students learning these topics in there school curriculum whereas the UK students learn these topics by attending extra classes or from their parents. Therefore, it is understandable that the Jordanian student will express more understanding of the tutoring topics.

8.4.5.3. Tutoring Content (Questionnaire) - Results and Discussion

The tutoring content was examined by asking the students a statement, which was “Abdullah the tutor provides me with information that I understand”, which illustrated as questionnaire question 5 “Q5” in (Figure 8.1 GQM Model for Abdullah CITS Evaluation). Figure 8.31 shows that there are 41.4% of the students were quite happy and understood the tutoring content, and 58.6% of the students expressed that they felt neutral when rating this question.

Table 8.31 also illustrates that there are a significant difference between the UK, and Jordanian students they rate this question neutral (46.6% of UK and 12.1% of Jordan). Figure 8.21, shows that there is a significant difference between the students from different location group rating this question as normal. It also indicates that the students in the UK and Jordan have the same feeling (i.e. happy) when they rating this question.

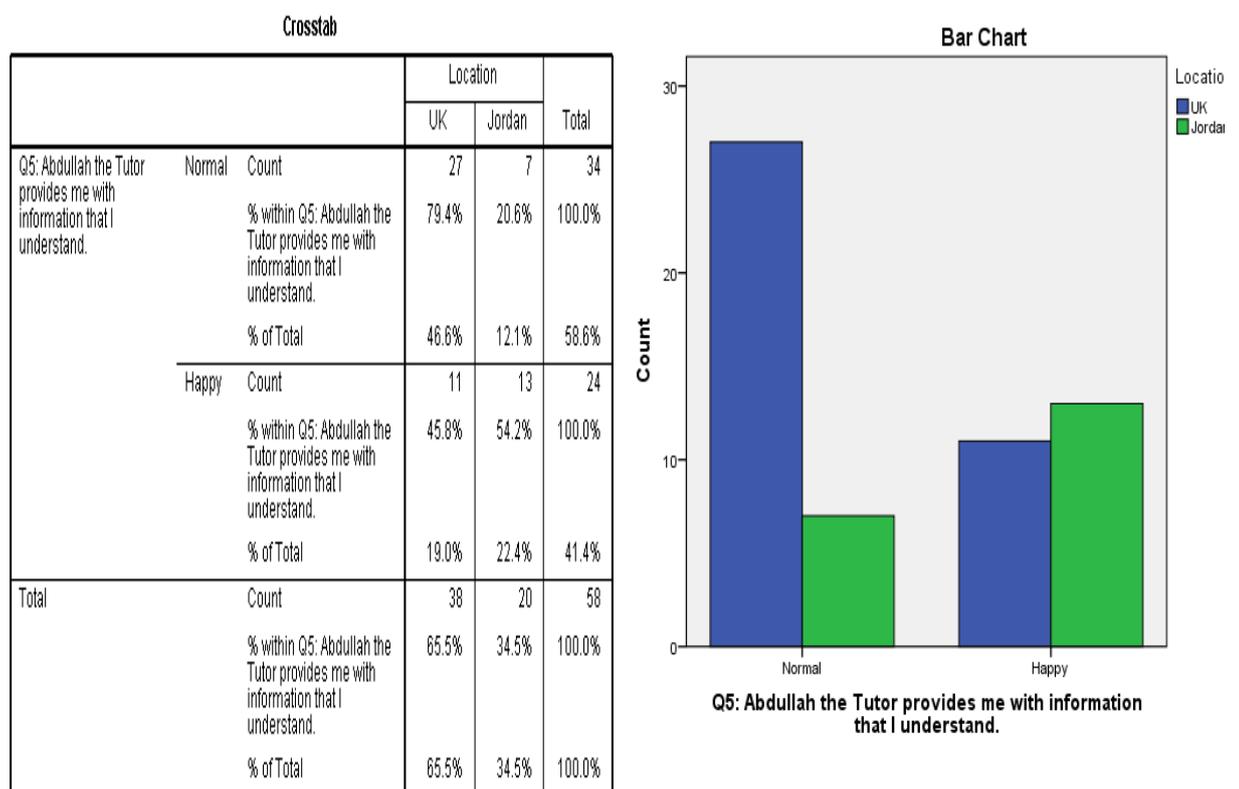


Figure 8.21 Q5 Between the Location Chart

Table 8.31 Crosstab * Location - Q5

A Chi-square test in Table 8.32 shows that there is a strong statistically significant difference between the locations when the students rate this question (p value is less than .05).

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.021 ^a	1	.008
Continuity Correction ^b	5.614	1	.018
Likelihood Ratio	7.047	1	.008
Fisher's Exact Test			
Linear-by-Linear Association	6.900	1	.009
N of Valid Cases	58		

- a. 0 cells (.0%) have expected count less than 5.
The minimum expected count is 8.28.
- b. Computed only for a 2x2 table

Table 8.32 Chi-Square Test * Location - Q5

Table 8.33 shows that there is not a significant difference (p value = 0.684 which is greater than .05) between the year group (year 5 and 6), when the students rating this question.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.165 ^a	1	.684
Continuity Correction ^b	.019	1	.890
Likelihood Rati	.166	1	.684
Fisher's Exact Test			
Linear-by-Linear Association	.163	1	.687
N of Valid Cases	58		

- a. 0 cells (.0%) have expected count less than 5.
The minimum expected count is 10.76.
- b. Computed only for a 2x2 table

Table 8.33 Chi-Square Test * Year Group – Q5

Table 8.34 and Figure 8.22 illustrates that there is almost the same level of agreement in each category between the student year groups when rating this question.

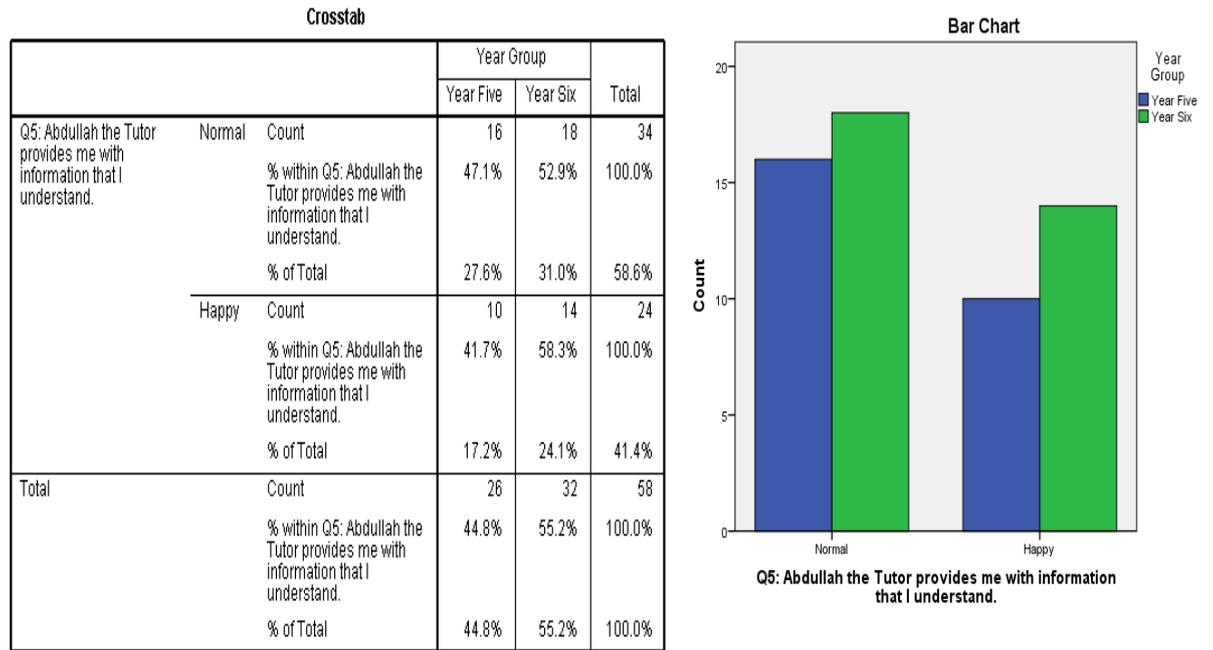


Table 8.34 Crosstab * Year Group -Q5

Figure 8.22 Q5 Between Year Group Chart

Table 8.35 shows that there a strong statistically significant difference (p value = 0.008) between the gender in the whole sample when rating this question.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.108 ^a	1	.008
Continuity Correction ^b	5.757		.016
Likelihood Ratio	7.282	1	.007
Fisher's Exact Test			
Linear-by-Linear Association	6.985	1	.008
N of Valid Cases	58		

a. 0 cells (.0%) have expected count less than 5.

The minimum expected count is 12.00.

b. Computed only for a 2x2 table

Table 8.35 Chi-Square Test * Gender - Q5

Table 8.36 and Figure 8.23 illustrate that the male students are happier (29.3%), when rating this question than the female students (12.1%). In addition, female students who expressed a neutral feeling have a higher percentage than male students in this category.

			Gender		Total
			Male	Female	
Q5: Abdullah the Tutor provides me with information that I understand.	Normal	Count	12	22	34
		% within Q5: Abdullah the Tutor provides me with information that I understand.	35.3%	64.7%	100.0%
		% of Total	20.7%	37.9%	58.6%
	Happy	Count	17	7	24
		% within Q5: Abdullah the Tutor provides me with information that I understand.	70.8%	29.2%	100.0%
		% of Total	29.3%	12.1%	41.4%
Total	Count	29	29	58	
	% within Q5: Abdullah the Tutor provides me with information that I understand.	50.0%	50.0%	100.0%	
	% of Total	50.0%	50.0%	100.0%	

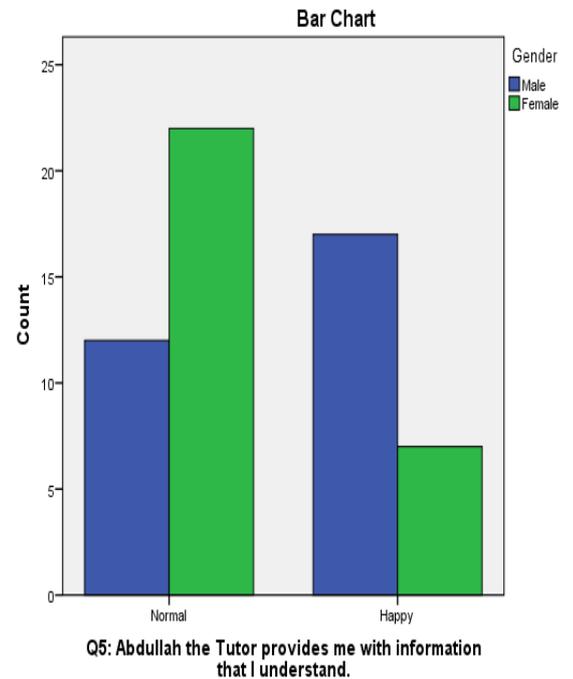


Table 8.36 Crosstab * Gender - Q5

Figure 8.23 Q5 Between the Gender Chart

8.4.5.4. Tutoring Content (Questionnaire) Question Conclusion

The results from this experiment can be summarised that the majority of UK students have a neutral feeling (79.4%) when they rate the question (Abdullah the Tutor provide me with information that I understand) compared to the Jordanian students (20.6%). Almost the same percentages of UK and Jordanian students expressed a happy feeling when rating this question.

In addition to that, there was also a significant difference in the percentage between the male and female students rating this question in both categories (normal and happy). From these results, it can be concluded that the Jordanian students found the tutoring content more understandable than the UK students.

8.4.5.5. Quality of Teaching (Questionnaire) - Results and Discussion

The teaching quality of Abdullah ATA-CITS was examined through the user evaluation questionnaire. The statement that the students were asked to rate was “Abdullah the tutor does not provide too much information to remember” (illustrated as questionnaire question 6 “Q6” in Figure 8.1 GQM Model for Abdullah CITS Evaluation). This statement related to the teaching quality as the tutoring content should be adequate to teach the topic yet not overwhelm the student with too much information.

A Chi-square test Table 8.37 shows that there is a strong statistically significant difference between the locations when the students rate this statement (p value is less than .05).

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.200 ^a	2	.027
Likelihood Ratio	8.533	2	.014
Linear-by-Linear Association	7.073	1	.008
N of Valid Cases	58		

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is 1.72.

Table 8.37 Chi-Square Test * Location - Q6

Table 8.38 shows that there are almost quarter of the students were happy about the information that was given by Abdullah ATA-CITS (22.4%). While the majority of the students (69%) had a neutral feeling about the information given by Abdullah ATA-CITS. Only five students from the UK group expressed that they were not happy with the information during the tutorial.

Figure 8.24 illustrates that the students in the UK have a neutral feeling about the amount of information given by Abdullah ATA-CITS during the tutoring session with 48.3% expressing a natural feeling in comparison with the Jordanian students, which was 20.7% in same category. 13.8% of the Jordanian students and 8.6% of the UK students expressed that they were happy with the amount of information provided by Abdullah ATA-CITS.

		Crosstab		Location		Total
		UK	Jordan	UK	Jordan	
Q6: Abdullah the Tutor does not provide too much information to remember.	Sad	Count	5	0	5	
		% within Q6: Abdullah the Tutor does not provide too much information to remember.	100.0%	.0%	100.0%	
		% of Total	8.6%	.0%	8.6%	
	Normal	Count	28	12	40	
		% within Q6: Abdullah the Tutor does not provide too much information to remember.	70.0%	30.0%	100.0%	
		% of Total	48.3%	20.7%	69.0%	
	Happy	Count	5	8	13	
		% within Q6: Abdullah the Tutor does not provide too much information to remember.	38.5%	61.5%	100.0%	
		% of Total	8.6%	13.8%	22.4%	
Total	Count	38	20	58		
	% within Q6: Abdullah the Tutor does not provide too much information to remember.	65.5%	34.5%	100.0%		
	% of Total	65.5%	34.5%	100.0%		

Table 8.38 Crosstab * Location - Q6

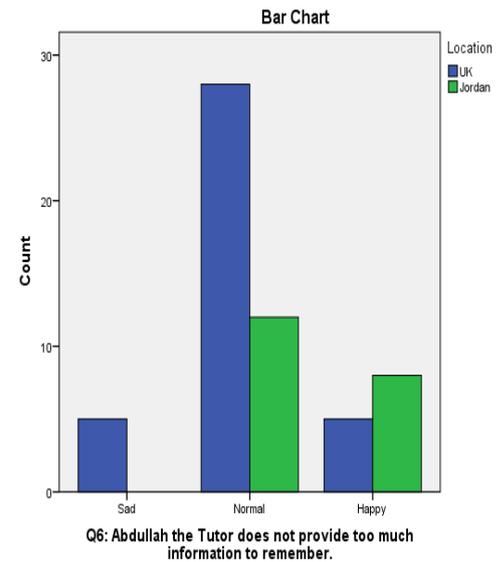


Figure 8.24 Q6 Between the Location Chart

Table 8.39 shows that there is not a significant difference (p value = 0.972) between the year group (year 5 and 6) related to this question.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.057 ^a	2	.972
Likelihood Ratio	.057	2	.972
Linear-by-Linear Association	.040	1	.841
N of Valid Cases	58		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 2.24.

Table 8.39 Chi-Square Test * Year Group - Q6

Figure 8.25 shows that the majority of students involved in the evaluation had a neutral feeling concerning this statement (the amount information given during the tutoring session).

Crosstab

			Year Group		Total
			Year Five	Year Six	
Q6: Abdullah the Tutor does not provide too much information to remember.	Sad	Count	2	3	5
		% within Q6: Abdullah the Tutor does not provide too much information to remember.	40.0%	60.0%	100.0%
		% of Total	3.4%	5.2%	8.6%
	Normal	Count	18	22	40
		% within Q6: Abdullah the Tutor does not provide too much information to remember.	45.0%	55.0%	100.0%
		% of Total	31.0%	37.9%	69.0%
	Happy	Count	6	7	13
		% within Q6: Abdullah the Tutor does not provide too much information to remember.	46.2%	53.8%	100.0%
		% of Total	10.3%	12.1%	22.4%
Total	Count	26	32	58	
	% within Q6: Abdullah the Tutor does not provide too much information to remember.	44.8%	55.2%	100.0%	
	% of Total	44.8%	55.2%	100.0%	

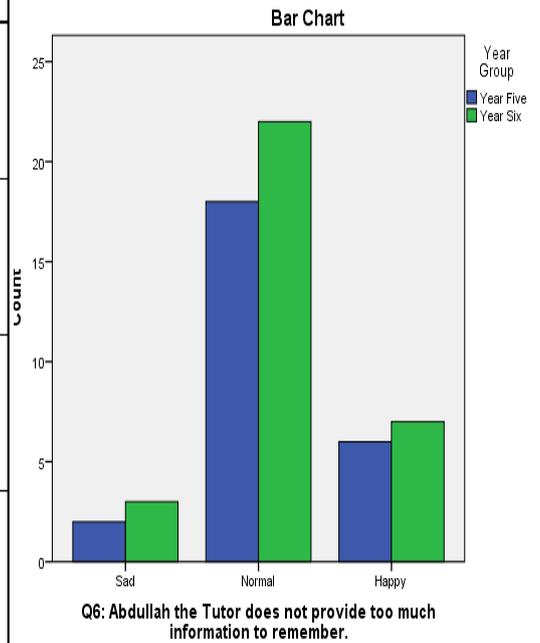


Table 8.40 Crosstab * Year Group - Q6

Figure 8.25 Q6 Between Year Group Chart

Table 8.41 shows that there is not a significant difference (p value = 0.871 which is greater than .05) between the gender, and the level of agreement in relation to this question.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.277 ^a	2	.871
Likelihood Ratio	.278	2	.870
Linear-by-Linear Association	.233	1	.630
N of Valid Cases	58		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 2.50.

Table 8.41 Chi-Square Test * Gender - Q6

Table 8.42 and Figure 8.26 illustrates that there is almost the same level of agreement in each category between the student's gender when rating this question.

			Gender		Total
			Male	Female	
Q6: Abdullah the Tutor does not provide too much information to remember.	Sad	Count	2	3	5
		% within Q6: Abdullah the Tutor does not provide too much information to remember.	40.0%	60.0%	100.0%
		% of Total	3.4%	5.2%	8.6%
	Normal	Count	20	20	40
		% within Q6: Abdullah the Tutor does not provide too much information to remember.	50.0%	50.0%	100.0%
		% of Total	34.5%	34.5%	69.0%
	Happy	Count	7	6	13
		% within Q6: Abdullah the Tutor does not provide too much information to remember.	53.8%	46.2%	100.0%
		% of Total	12.1%	10.3%	22.4%
Total	Count	29	29	58	
	% within Q6: Abdullah the Tutor does not provide too much information to remember.	50.0%	50.0%	100.0%	
	% of Total	50.0%	50.0%	100.0%	

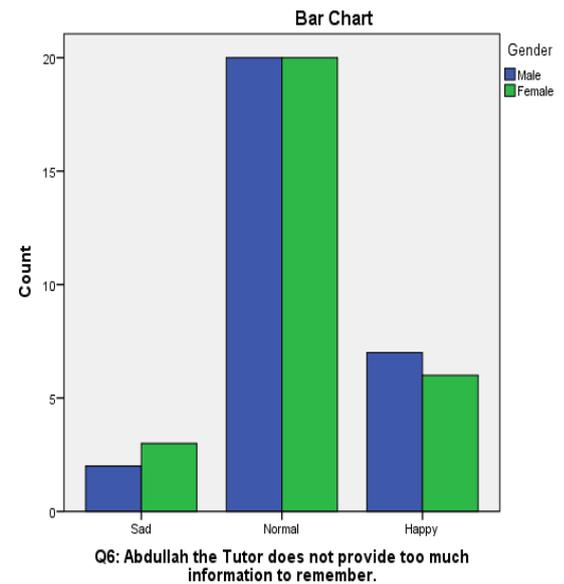


Figure 8.26 Q6 Between the Gender Chart

Table 8.42 Crosstab * Gender - Q6

8.4.5.6. Quality of Teaching (Questionnaire question) Conclusion

it can be summarised from the results of this experiment that, the Jordanian students are expressed more happiness with the amount of information's delivered by Abdullah ATA-CITS during the tutoring session (61.5%), in comparison with the UK students (38.5) in the same category. In addition, there are five UK's students who expressed that they were not happy with the amount of information, while there are no students from the Jordan's group has the same feeling (i.e. not happy).

These results imply that the Jordanian student expressed more satisfaction with the amount of information provided by Abdullah ATA-CITS compared to the UK students. This could be because the Jordanian students are more familiar with the tutorial information content. Some of the UK students expressed that they were not satisfied with the amount of information when rating this question probably because they were unfamiliar with the tutoring topics, which led to them not being able to retain/remember the information/content of the tutoring session.

8.4.6. Experiment 2 (Adaptability to Student Knowledge Level) Conclusion

Experiment 2 as specified in section (8.4.4), evaluates four metrics related to hypothesis H2 (It is possible to adapt to the student's knowledge level from a tutoring discourse with an intelligent tutoring conversational agent). Results obtained from the log file, have been used for measuring and evaluating two metrics, which are answers classification metric, and questions classification metric as described in (Figure 8.1).

The answers classification metrics show that Jordanian year six students expressed more understanding of the tutoring topics/content during Abdullah ATA-CITS session compared to the year five UK students. The results showed that the year six Jordanian students were able to understand the questions being asked in the tutoring session in the default question style (a type of questions suitable for the selected age group).

In addition to these results year five UK students were asked more detailed questions during the tutoring (a type of question is designed for struggling students, which is presented in a detailed format).

Two questions related to H2, were asked the students through the questionnaire after their tutoring session with Abdullah ATA-CITS, to measure their level of agreement with the questions/statements. The first statement was "Abdullah the Tutor provides me with information that I understand", and the second statement was "Abdullah the tutor does not provide too much information to remember". The first statement was related to the tutoring content; the results show that the majority of the students involved in the evaluation expressed a neutral or happy feeling concerning this question. This means that most of the student who interacted with Abdullah ATA-CITS understood the tutoring content been delivered. The second statement was linked to measure the quality of teaching. The results found that the Jordanian year six students are happier than the year five UK students. This could be due to the students in Jordan being taught and practise Arabic and Islamic education in the everyday curriculum, and the effect of the Islamic environment in the Arabic countries such as Jordan. Therefore, the Jordanian student were able to cope better with the tutoring content compared to the UK students.

8.4.7. Experiment 3: System Robustness

The robustness of Abdullah ATA-CITS will be measured by utilising the log file (7.3.4.1.1) which records conversation related variables captured during the tutoring session, such as:

1. Completion time - the time (in seconds) used by user to answer or to reply to a question asked by Abdullah CITS in the tutoring session.
2. Fired rules - the rules that were fired during the conversation.
3. Utterances not valid - utterances that are classed not valid by Abdullah ATA-CITS such as
 - Utterances that do not belonging to the tutoring topic.
 - Utterance not written in Arabic language.
 - Utterance that is empty, or has one or more special characters.
4. System crash - the number of system crashes during the conversation with all user.

This experiment is designed to test hypothesis H3 “is it possible to develop a good quality Arabic CITS”, which is defined in (section 8.2.1). The intention behind this experiment is to test the tutoring success of the Abdullah ATA-CITS. Both objective and subjective metrics Table 8.43 were used to answer the questions related to H3, as illustrated in (Figure 8.1 GQM Model for Abdullah CITS Evaluation).

Metric to be Evaluated	Mode of Evaluation	Subjective / Objective
Completion Time	Log file	Objective Metric
Rejected Utterances	Log file	Objective Metric
Fired Rule	Log file	Objective Metric
# System Crash	Log file	Objective Metric
Utterances Not Valid	Log file	Objective Metric
Usability of Abdullah CITS	Questionnaire	Subjective Metric
Quality of Teaching & Tutorial	Questionnaire	Subjective Metric

Table 8.43 Experiment three Metrics

8.4.8. Experiment 3 Results and Discussion

This section will present the collated results of all five metrics (Table 8.43), captured during the tutoring session and part of the student's questionnaire which they completed after the Abdullah ATA-CITS tutoring session.

8.4.8.1. Rejected and Not Valid Utterance – Results and Discussion

Handling errors and invalid utterances can improve the robustness of the system (Clark and Brennan, 1991). Figure 8.27 shows the percentage of utterances that did not belong to the current topics of discussion in Abdullah ATA-CITS (2.85%), utterances that are not written in the Arabic language (0.85%), empty utterances (0.15%), and rejected utterances (1.85%).

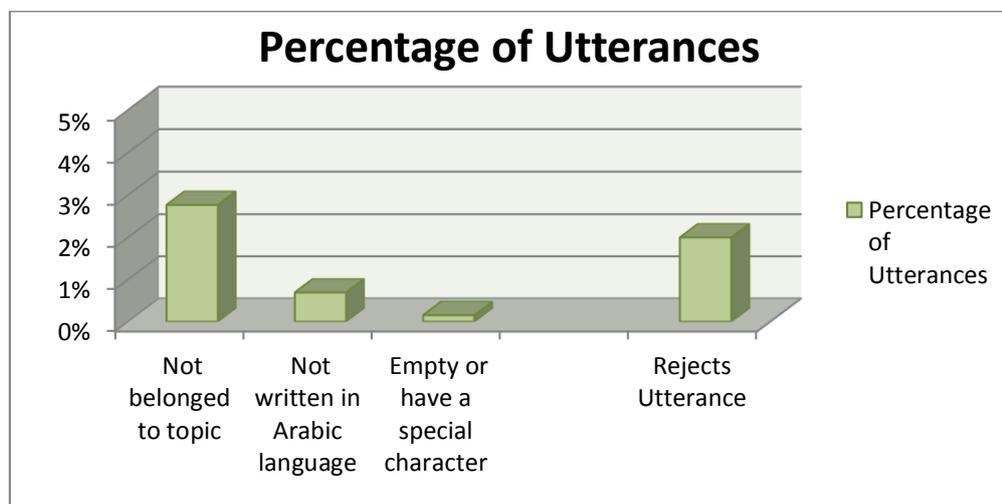


Figure 8.27 Percentages of Not Valid Utterances

Table 8.44 shows an example of the users/participants (i.e. Shmes), replied to a question asked by Abdullah ATA-CITS with the utterance not written in Arabic language. Abdullah ATA-CITS recognizes that this utterance is not written in the Arabic language, and then replay to the user that Abdullah ATA-CITS only understands the Arabic language.

Abdullah ATA-CITS also repeated the previous question to the user after explaining that Arabic language is the only language spoken by Abdullah ATA-CITS.

Original Arabic dialogue	English Translated Abdullah ATA-CITS	Utterance classification
عبد الله : ما هو الركن الاخير من اركان الاسلام , والذي يجب ادائه مرة واحدة في العمر ؟	Abdullah: what is the last pillar of Islam, which must performances once in a lifetime?	Topic belonged to Branch 3 (To know your religion)
شمس : are you idiot	Shmes: are you idiot	utterance Not written in Arabic language
عبد الله : انا اسف ولاكني لا افهم ألا اللغة العربية . هل تستطيع الاجابة عن سؤالي (ماهو الركن الاخير من اركان الاسلام , والذي يجب ادائه مرة واحدة في العمر ؟)	Abdullah: I am sorry but I can only understand Arabic language. Can you answer my question (what is the last pillar of Islam, which must performances once in a lifetime?)	

Table 8.44 Utterances not belonged to topic example- Dialogue 1

The second example (Table 8.45) shows that the user (i.e. Mariam), answered a question asked by Abdullah ATA-CITS by another question. Abdullah ATA-CITS recognizes that this is a question not related to the current topic, but it is related to the main branch assigned to the user/student at the starting of the tutoring session (i.e. to know your prophet). In this situation Abdullah ATA-CITS, responded with an answer to the question posed by the user, and then repeated the previous question asked in the tutoring session in order to direct the discussion back on to the tutoring topic.

Original Arabic dialogue	English Translated Abdullah ATA-CITS	Utterance classification
عبد الله : عبد المسلمون الله سرا في السنين الأولى من البعثة . هل تعلم اين هاجر الرسول محمد ؟	Abdullah: Muslims worship first years of Islam in a secret way. Do you know where prophet Muhammed is migrant?	Topic belonged to Branch 2 (To know your prophet)
مريم : من هو ابو الرسول محمد ؟	Mariam: who is prophet Muhammed father?	Question Not belonged to current the topic
عبد الله : عبد الله بن عبد المطلب هو ابو الرسول محمد .الرجاء هل تستطيع الاجابة عن سؤالي هل تعلم اين هاجر الرسول محمد ؟	Abdullah: Prophet's father was Abdullah, who was the son of Abdul Muttalib. Can you please answer my question (Do you know where prophet Muhammed is migrant?)	Topic belonged to Branch 2 (To know your prophet)
مريم : الى المدينة	Mariam: to al Madina	Answer belonged to the current topic
عبد الله : ممتاز , في سنة 622 هاجر محمد صلى الله عليه وسلم برفقة 70 مؤمنا الى المدينة	Abdullah: excellent, In 622, Muhammad and around 70 Meccan believers left Mecca for sanctuary in al Madina	Topic belonged to Branch 2 (To know your prophet)

Table 8.45 Utterances not belonged to topic example- Dialogue 2

The percentages of utterances that were not belonging to the current topic, or were rejected utterances (i.e. I do not know, I would prefer not to discuss this right now, and this is none of your business), all reflect how good the system was designed or whether it can achieve the goal for tutoring or not (Ginzburg, 1996) . Since the percentages of the not valid utterances (2.85%), or rejected utterances (1.85%), are very low percentages, it can be concluded that Abdullah ATA-CITS is a well-designed robust system, and suitable for the task it was designed for.

8.4.8.2. Fired Rule – Results and Discussion

The number of fired rules during the tutoring conversation will determine whether the students are following the right path of the tutoring. It can be seen from Figure 8.28 that most of the rules that fired during the tutoring session belonged to the current tutoring session/topic (86.93% for Branch 1, 97.30% for Branch 2, and 80.43% for Branch 3).

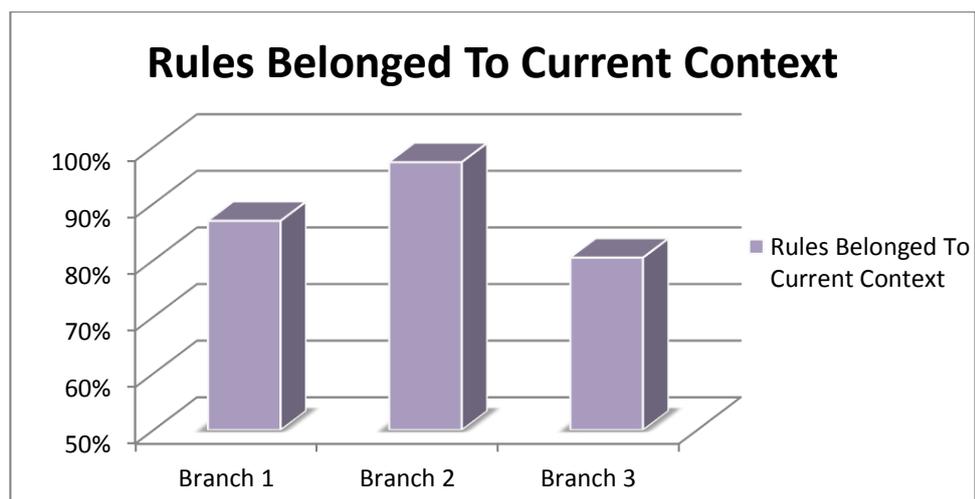


Figure 8.28 Percentage of Fired Rule

The highest percentage of the rules fired during the tutoring session that were related to the current topic was 97.30%, from this result it can be determined that the participants/users found this branch/fundamental (branch 2 - To Know your prophet) more understandable than the other fundamental principles.

This result is also reflected throughout the experiments three that Branch 2 was the most branch which the users engaging. Since Branch 2 contained easier tutoring content and it was a topic that the students in younger age group are most familiar with (al-Uthaymeen). Hence, this was the branch/tutoring topic that contained the least amount of context discussion, as illustrated in Figure 8.28 .

8.4.8.3. Usability of Abdullah ATA-CITS (Questionnaire) - Results and Discussion

The effectiveness of Abdullah ATA-CITS was examined by asking the students two questions, as illustrated in section (8.2.3). These two questionnaire's questions are used to examine the usability of Abdullah ATA-CITS, after the tutoring session is ended. These questions are:

- Whether Abdullah the Tutor is enjoyable to use?
- Would you like to use Abdullah the Tutor again?

8.4.8.3.1. Usability Questionnaire (Question 1: Whether Abdullah the Tutor enjoyable to use?)

The students were rating the usability questionnaire question 1 (which is mentioned in Figure 8.1 GQM Model for Abdullah CITS Evaluation, as questionnaire question 1 "Q1"). It can be seen from Table 8.46 that 63.8% of the students found the tutoring enjoyable. 36.2% of the students expressed that they felt neutral about their interaction with Abdullah ATA-CITS.

Table 8.46 and Figure 8.29 also illustrates that the students in the UK expressed more enjoyment when using Abdullah ATA-CITS with a percentage of 51.7% happy in comparison with Jordan, which was 12.1%. 13.8% of the UK students have a neutral feeling in comparison with Jordan students with 22.4%.

Crosstab

			Location		Total
			UK	Jordan	
Q1: Abdullah the Tutor is enjoyable to use.	Normal	Count	8	13	21
		% within Q1: Abdullah the Tutor is enjoyable to use.	38.1%	61.9%	100.0%
		% of Total	13.8%	22.4%	36.2%
	Happy	Count	30	7	37
		% within Q1: Abdullah the Tutor is enjoyable to use.	81.1%	18.9%	100.0%
		% of Total	51.7%	12.1%	63.8%
Total	Count	38	20	58	
	% within Q1: Abdullah the Tutor is enjoyable to use.	65.5%	34.5%	100.0%	
	% of Total	65.5%	34.5%	100.0%	

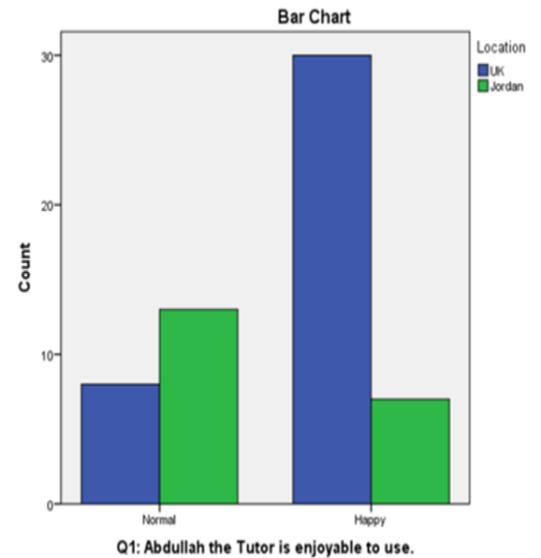


Table 8.46 Crosstab * Location - Q1

Figure 8.29 Q1 Between the Location Chart

Since the P value (the probability of obtaining the observed sample results), is less than .05 as show in (Table 8.47) it can be said that there is a strong statistically difference in opinion between the locations when the students rate this question.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.957^a	1	.001
Continuity Correction ^b	9.137	1	.003
Likelihood Ratio	10.922	1	.001
Fisher's Exact Test			
Linear-by-Linear Association	10.768	1	.001
N of Valid Cases	58		

Table 8.47 Chi-Square Test * Location - Q1

Table 8.48 illustrates that there is not a significant difference (p value = 0.384 which is greater than .05) between the year group (year 5 and 6), when rating this question.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.759 ^a	1	.384
Continuity Correction ^b	.356	1	.551
Likelihood Ratio	.758	1	.384
Fisher's Exact Test			
Linear-by-Linear Association	.746	1	.388
N of Valid Cases	58		

a. 0 cells (.0%) have expected count less than 5.
b. The minimum expected count is 10.50.

Table 8.48 Chi-Square Test * Year Group – Q1

Figure 8.30 and Table 8.49 illustrates that there is a minor difference between the students who feel happy in year 5 and year 6.

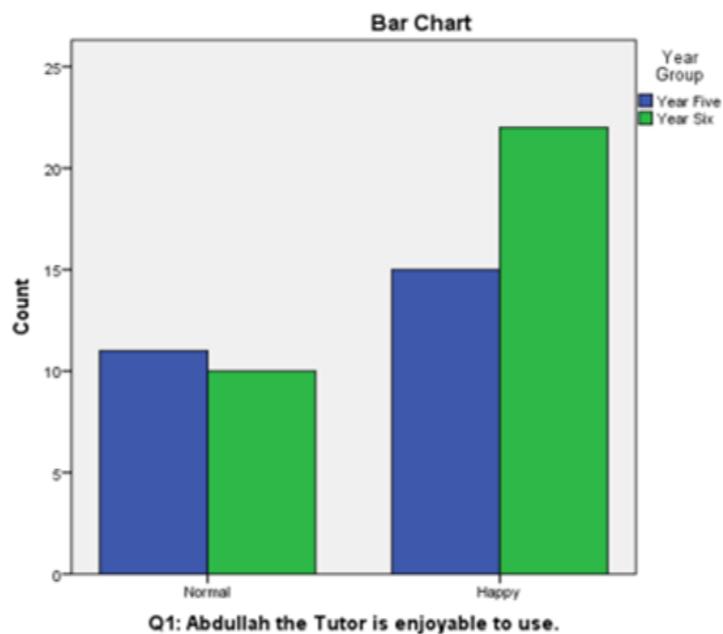


Figure 8.30 Q1 Between the Year Group Chart

Crosstab

			Year Group		Total
			Year Five	Year Six	
Q1: Abdullah the Tutor is enjoyable to use.	Normal	Count	11	10	21
		% within Q1: Abdullah the Tutor is enjoyable to use.	52.4%	47.6%	100.0%
		% of Total	19.0%	17.2%	36.2%
	Happy	Count	15	22	37
		% within Q1: Abdullah the Tutor is enjoyable to use.	40.5%	59.5%	100.0%
		% of Total	25.9%	37.9%	63.8%
Total	Count	26	32	58	
	% within Q1: Abdullah the Tutor is enjoyable to use.	44.8%	55.2%	100.0%	
	% of Total	44.8%	55.2%	100.0%	

Table 8.49 Crosstab * Year Group -Q1

Table 8.50 highlights that there is not a significant difference (p value = 0.785 which is greater than .05) between the gender, and the students rating this question.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.075^a	1	.785
Continuity Correction ^b	.000	1	1.000
Likelihood Ratio	.075	1	.785
Fisher's Exact Test			
Linear-by-Linear Association	.073	1	.787
N of Valid Cases	58		

- i) 0 cells (.0%) have expected count less than 5.
 i) The minimum expected count is 10.50

Table 8.50 Chi-Square Test * Gender - Q1

Table 8.51 and Figure 8.31 illustrates that the gender groups approximately have the same feeling when rating this question.

Crosstab

			Gender		Total
			Male	Female	
Q1: Abdullah the Tutor is enjoyable to use.	Normal	Count	10	11	21
		% within Q1: Abdullah the Tutor is enjoyable to use.	47.6%	52.4%	100.0%
		% of Total	17.2%	19.0%	36.2%
	Happy	Count	19	18	37
		% within Q1: Abdullah the Tutor is enjoyable to use.	51.4%	48.6%	100.0%
		% of Total	32.8%	31.0%	63.8%
Total	Count	29	29	58	
	% within Q1: Abdullah the Tutor is enjoyable to use.	50.0%	50.0%	100.0%	
	% of Total	50.0%	50.0%	100.0%	

Table 8.51 Crosstab * Gender - Q1

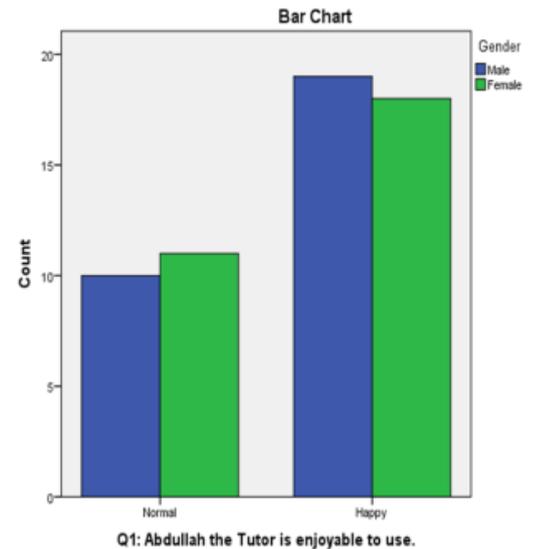


Figure 8.31 Q1 Between the Gender Chart

In section 8.4.8.4 the findings from the question (Q1 “Abdullah the tutor is enjoyable to use”), will be discussed in details.

8.4.8.3.2. Usability Questionnaire (Question 2: Would you like to use Abdullah the Tutor again?)

The students were rating the usability questionnaire question 2 (which is mentioned in Figure 8.1 GQM Model for Abdullah CITS Evaluation, as questionnaire question 8 “Q8”). Table 8.52 determines that 60.3% of the students are a happy with the tutoring, and enjoyed their interaction with Abdullah ATA-CITS. 37.9% of the students expressed that they felt neutral about their interaction with Abdullah ATA-CITS. Only 1.7% of the students expressed that they would not to use Abdullah the tutor again. The surveyed students were asked if they would use Abdullah the tutor again. Figure 8.32 also shows that the students in the UK are more likely to use Abdullah the tutor again with a percentage of 34.5% happy in comparison with Jordanian students, which was 25.9%. In addition to these results, almost thirty percent of the UK students have a neutral feeling in comparison with the Jordanian students with less than ten percentages.

Crosstab

			Location		Total
			UK	Jordan	
Q8: Would you like to use Abdullah the Tutor again?	Sad	Count	1	0	1
		% within Q8: Would you like to use Abdullah the Tutor again?	100.0%	.0%	100.0%
		% of Total	1.7%	.0%	1.7%
	Normal	Count	17	5	22
		% within Q8: Would you like to use Abdullah the Tutor again?	77.3%	22.7%	100.0%
		% of Total	29.3%	8.6%	37.9%
	Happy	Count	20	15	35
		% within Q8: Would you like to use Abdullah the Tutor again?	57.1%	42.9%	100.0%
		% of Total	34.5%	25.9%	60.3%
Total	Count	38	20	58	
	% within Q8: Would you like to use Abdullah the Tutor again?	65.5%	34.5%	100.0%	
	% of Total	65.5%	34.5%	100.0%	

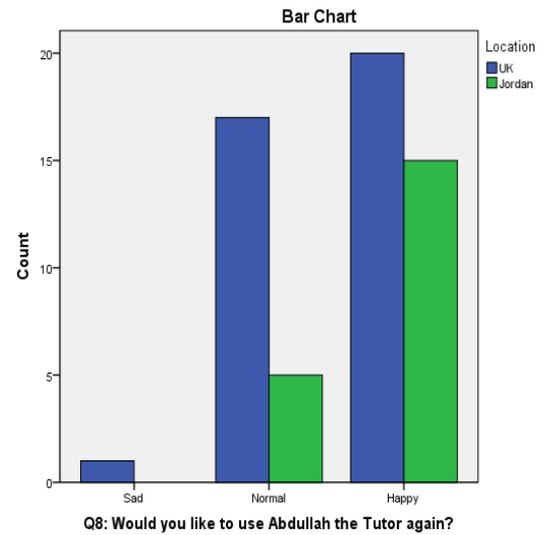


Figure 8.32 Q8 Between the Location Chart

Table 8.52 Crosstab * Location - Q8

The P value was found to be more than .05 (Table 8.53), therefore, it can be concluded that there is not a significant difference between the locations when the students rate this question.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.958 ^a	2	.228
Likelihood Ratio	3.340	2	.188
Linear-by-Linear Association	2.905	1	.088
N of Valid Cases	58		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is .34.

Table 8.53 Chi-Square Test * Location - Q8

Figure 8.33 illustrates that both groups of students are generally happy when they use Abdullah ATA-CITS, and they would like to use it again (with a percentage of 51.4% happy for year 6 and 48.6% happy for year 5, as shown in Table 8.54.

Years 5 and year 6 both expressed a neutral feeling about whether to use Abdullah ATA-CITS again with a marginal difference between the two groups (24.1% for year 6 and 13.8% for year 5).

			Crosstab		
			Year Group		Total
			Year Five	Year Six	
Q8: Would you like to use Abdullah the Tutor again?	Sad	Count	1	0	1
		% within Q8: Would you like to use Abdullah the Tutor again?	100.0%	.0%	100.0%
		% of Total	1.7%	.0%	1.7%
	Normal	Count	8	14	22
		% within Q8: Would you like to use Abdullah the Tutor again?	36.4%	63.6%	100.0%
		% of Total	13.8%	24.1%	37.9%
	Happy	Count	17	18	35
		% within Q8: Would you like to use Abdullah the Tutor again?	48.6%	51.4%	100.0%
		% of Total	29.3%	31.0%	60.3%
Total	Count	26	32	58	
	% within Q8: Would you like to use Abdullah the Tutor again?	44.8%	55.2%	100.0%	
	% of Total	44.8%	55.2%	100.0%	

Table 8.54 Crosstab * Year Group -Q8

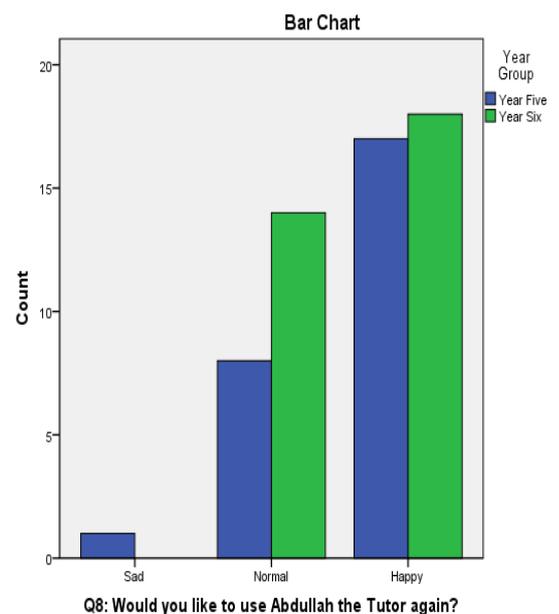


Figure 8.33 Q8 Between the Year Group Chart

However, there are a very small percentage of year 5 students who stated that they would not like to use Abdullah ATA-CITS again.

Table 8.55 shows that there is not a significant difference (p value = 0.356 which is greater than .05) between the year group (year 5 and 6), and students rating this question.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.066 ^a	2	.356
Likelihood Ratio	2.450	2	.294
Linear-by-Linear Association	.142	1	.706
N of Valid Cases	58		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is .45.

Table 8.55 Table 8.54 Chi-Square Test * Year Group – Q8

Table 8.56 shows that there is not a significant relationship (p value = 0.598 which is greater than .05) between the gender groups of the students rating this question.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.029 ^a	2	.598
Likelihood Ratio	1.415	2	.493
Linear-by-Linear Association	.245	1	.621
N of Valid Cases	58		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is .50.

Table 8.56 Chi-Square Test * Gender - Q8

Table 8.57 and Figure 8.34 illustrates that the results in each category are very similar between the gender groups when rating this question. The findings from this question (Q8) will be illustrated in the next section (8.4.8.4).

Crosstab

			Gender		Total
			Male	Female	
Q8: Would you like to use Abdullah the Tutor again?	Sad	Count	1	0	1
		% within Q8: Would you like to use Abdullah the Tutor again?	100.0%	.0%	100.0%
		% of Total	1.7%	.0%	1.7%
	Normal	Count	11	11	22
		% within Q8: Would you like to use Abdullah the Tutor again?	50.0%	50.0%	100.0%
		% of Total	19.0%	19.0%	37.9%
	Happy	Count	17	18	35
		% within Q8: Would you like to use Abdullah the Tutor again?	48.6%	51.4%	100.0%
		% of Total	29.3%	31.0%	60.3%
Total	Count	29	29	58	
	% within Q8: Would you like to use Abdullah the Tutor again?	50.0%	50.0%	100.0%	
	% of Total	50.0%	50.0%	100.0%	

Table 8.57 Crosstab * Gender - Q8

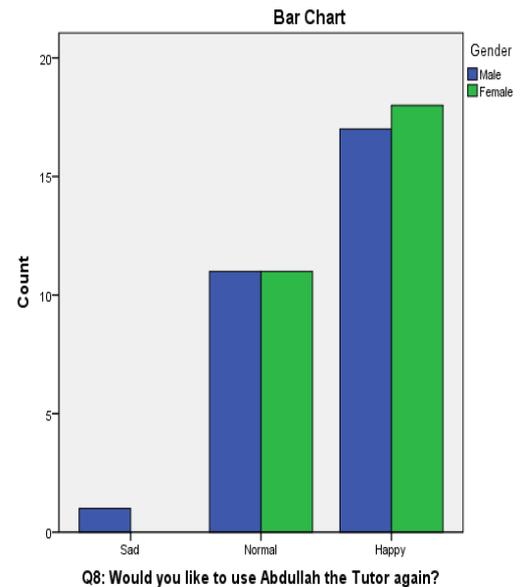


Figure 8.34 Q8 Between the Gender Chart

8.4.8.4. Usability Questionnaires (Question 1, and 2) Conclusion

The results which obtained from the students rating the questionnaire question one (8.4.8.3.1), and questionnaire question two (8.4.8.3.2), revealed that Abdullah ATA-CITS is perceived to be more effective in the UK in comparison to Jordan:

- UK students expressed a higher level of satisfaction when using Abdullah ATA-CITS than Jordanian student (51.7% for UK and 12.1 for Jordan).
- The majority of the students (with different group's location) enjoyed using Abdullah ATA-CITS.
- The majority of the UK students are enjoying when using Abdullah the tutor in comparison to Jordanian students.
- The majority of the students (98.3%) stated they would like to use Abdullah ATA-CITS again.
- UK students stating they would like to use Abdullah ATA-CITS again, with a percentage of (65.5% for UK, in comparison of 34.5% for Jordanian students).

The UK student found more of a novelty when using Abdullah ATA-CITS, rather than the students in Jordan who are taught in Arabic language every day, and most of the topics in Abdullah ATA-CITS are covered by the Jordanian curriculum. The UK students largely agreed about what for them were the most enjoyable and effective methods for learning (i.e. images, and videos). The UK students valued these learning methods founding more interest than the UK students.

8.4.8.5. Quality of Teaching (Questionnaire) - Results and Discussion

The quality of teaching was examined through the questionnaire by asking the students, the question (Q3) “do you remember what Abdullah has told you in the tutorial?”. A Chi-square test Table 8.58 shows that there is a strong statistically significant difference between the locations when the students rate this question (p value is less than .05).

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.798 ^a	1	.003
Continuity Correction ^b	7.159	1	.007
Likelihood Ratio	8.691	1	.003
Fisher's Exact Test			
Linear-by-Linear Association	8.646	1	.003
N of Valid Cases	58		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is .5.

b. Computed only for a 2x2 table

Table 8.58 Chi-Square Test * Location - Q3

Table 8.59 shows that the majority of the students are able to remember/retain what Abdullah ATA-CITS has taught them during the tutorial by marking 65.5% happy and 34.5% with a neutral feeling about their recall of the tutorial content. Table 8.59 and Figure 8.35 also illustrate that the students in the UK are able to remember more of what Abdullah the tutor taught them during the tutorial with a percentage of 51.7% happy in comparison with Jordan, which was 13.8%.

Crosstab

			Location		Total
			UK	Jordan	
Q3: Do you remember what Abdullah has told you in the tutorial?	Normal	Count	8	12	20
		% within Q3: Do you remember what Abdullah has told you in the tutorial?	40.0%	60.0%	100.0%
		% of Total	13.8%	20.7%	34.5%
	Happy	Count	30	8	38
		% within Q3: Do you remember what Abdullah has told you in the tutorial?	78.9%	21.1%	100.0%
		% of Total	51.7%	13.8%	65.5%
Total	Count	38	20	58	
	% within Q3: Do you remember what Abdullah has told you in the tutorial?	65.5%	34.5%	100.0%	
	% of Total	65.5%	34.5%	100.0%	

Table 8.59 Crosstab * Location - Q3

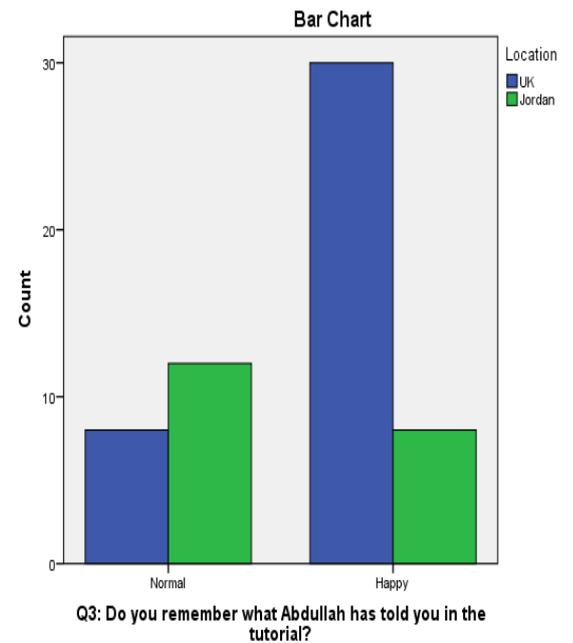


Figure 8.35 Q3 Between the Location Chart

From the students who expressed a neutral feeling concerning their recall of the tutoring session content, it was found that the results were very close between the two locations (20.7% for Jordan and 13.8% for UK). Table 8.60 shows that there is not a significant difference (p value = 0.566 which is greater than .05) between the year groups for the students rating this questions.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.330 ^a	1	.566
Continuity Correction ^b	.088	1	.767
Likelihood Ratio	.330	1	.566
Fisher's Exact Test			
Linear-by-Linear Association	.325	1	.569
N of Valid Cases	58		

a. 0 cells (.0%) have expected count less than 5.

The minimum expected count is 8.97.

b. Computed only for a 2x2 table

Table 8.60 Chi-Square Test * Year Group – Q3

Table 8.61 and Figure 8.36 illustrates that there is a minor difference between the students in year 5 and the students in year 6, with a percentage of 37.9% happy in year 6 in comparison 27.6% in year 5. Year 6 and year 5 were found to have the same neutral feeling (17.2%) about remembering the content of the tutorial.

		Year Group		Total	
		Year Five	Year Six		
Q3: Do you remember what Abdullah has told you in the tutorial?	Normal	Count	10	10	20
		% within Q3: Do you remember what Abdullah has told you in the tutorial?	50.0%	50.0%	100.0%
		% of Total	17.2%	17.2%	34.5%
	Happy	Count	16	22	38
		% within Q3: Do you remember what Abdullah has told you in the tutorial?	42.1%	57.9%	100.0%
		% of Total	27.6%	37.9%	65.5%
Total	Count	26	32	58	
	% within Q3: Do you remember what Abdullah has told you in the tutorial?	44.8%	55.2%	100.0%	
	% of Total	44.8%	55.2%	100.0%	

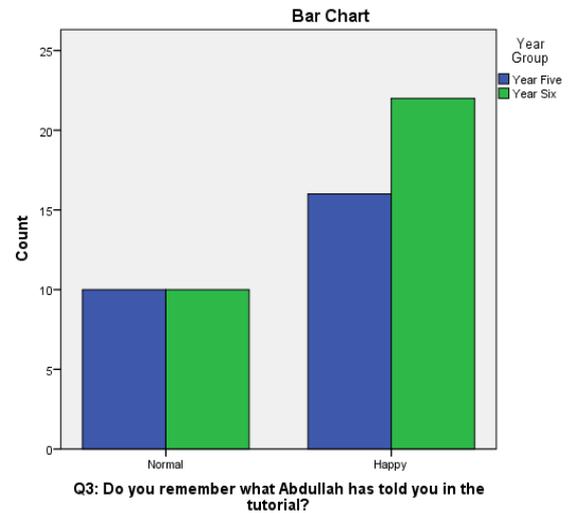


Table 8.61 Crosstab * Year Group -Q3

Figure 8.36 Q3 Between the Year Group Chart

Table 8.62 shows that there is not a significant difference (p value = 0.269 which is greater than .05) between the gender groups in the whole sample.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.221 ^a	1	.269
Continuity Correction ^b	.687	1	.407
Likelihood Ratio	1.227	1	.268
Fisher's Exact Test			
Linear-by-Linear Association	1.200	1	.273
N of Valid Cases	58		

a. 0 cells (.0%) have expected count less than 5.

The minimum expected count is 10.00.

b. Computed only for a 2x2 table

Table 8.62 Chi-Square Test * Gender - Q3

Table 8.63 and Figure 8.37 illustrates that there is a minor difference of opinion in the gender groups with relation to this question.

			Gender		Total
			Male	Female	
Q3: Do you remember what Abdullah has told you in the tutorial?	Normal	Count	8	12	20
		% within Q3: Do you remember what Abdullah has told you in the tutorial?	40.0%	60.0%	100.0%
		% of Total	13.8%	20.7%	34.5%
	Happy	Count	21	17	38
		% within Q3: Do you remember what Abdullah has told you in the tutorial?	55.3%	44.7%	100.0%
		% of Total	36.2%	29.3%	65.5%
Total	Count	29	29	58	
	% within Q3: Do you remember what Abdullah has told you in the tutorial?	50.0%	50.0%	100.0%	
	% of Total	50.0%	50.0%	100.0%	

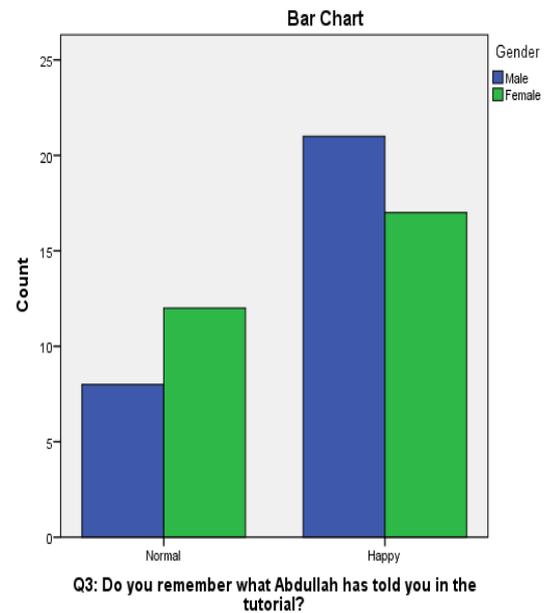


Table 8.63 Crosstab * Gender - Q3

Figure 8.37 Q3 Between the Gender Chart

8.4.8.6. Quality of Teaching (Questionnaire) – Conclusion

As stated in experiment 3 (quality of teaching questionnaire experiment), the results highlight that UK students are able to remember more what Abdullah ATA-CITS taught them in the tutoring session than Jordanian students with a percentages of (51.7% for UK students , and 13.8% for Jordanian students).

This result is demonstrate that the UK students expressed more satisfaction when using Abdullah ATA-CITS than the Jordanian students as illustrated in section (8.4.8.3.1). This means that the UK student would be more engaged and concentrating during their interaction with Abdullah ATA-CITS, which would result in more retention of the tutoring content.

In addition to these result it is also corroborated by the results of the pre and post-test scores (see section 8.4.2.1), with the UK student achieving a better average score than the Jordanian student.

8.4.8.7. Quality of tutorial (Questionnaire) - Results and Discussion

The quality of tutorial was examined by the questionnaire question (Q4) “It is easy to follow the structure of the topics?” as illustrated in (Figure 8.1 GQM Model for Abdullah CITS Evaluation).

A Chi-square test Table 8.64 shows that there is a strong significant difference between the location groups of students rating this question (p value is less than .05).

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.929 ^a	1	.002
Continuity Correction ^b	8.261	1	.004
Likelihood Ratio	10.238	1	.001
Linear-by-Linear Association	9.758	1	.002
N of Valid Cases	58		
0 cells (.0%) have expected count less than 5. The minimum expected count is 9.31.b. Computed only for a 2x2 table			

Table 8.64 Chi-Square Test * Location - Q4

Table 8.65 demonstrates that the results show 53.4% of the whole sample is quite happy with the structure of the tutoring topics. 46.6% of the students expressed that they felt neutral about the tutoring structure.

Table 8.65 and Figure 8.38 also illustrates that the students in the UK are happier with the structure of the tutorial with a percentage of 44.8% happy in comparison with Jordanian students, which was only 8.6%. These results might reflect the understanding of the tutorial’s structure by the UK’s students in comparison with the Jordanian students who might not like/agree about the Abdullah ATA-CITS tutorial structure.

In addition to these result the students who expressed a neutral feeling about how easy to follow the structure of the tutoring session, it was found that the results were very close between the two locations (25.9% of Jordan and 20.7% of UK).

Crosstab

			Location		Total
			UK	Jordan	
Q4: It is easy to follow the structure of the topics.	Normal	Count	12	15	27
		% within Q4: It is easy to follow the structure of the topics.	44.4%	55.6%	100.0%
		% of Total	20.7%	25.9%	46.6%
	Happy	Count	26	5	31
		% within Q4: It is easy to follow the structure of the topics.	83.9%	16.1%	100.0%
		% of Total	44.8%	8.6%	53.4%
Total	Count	38	20	58	
	% within Q4: It is easy to follow the structure of the topics.	65.5%	34.5%	100.0%	
	% of Total	65.5%	34.5%	100.0%	

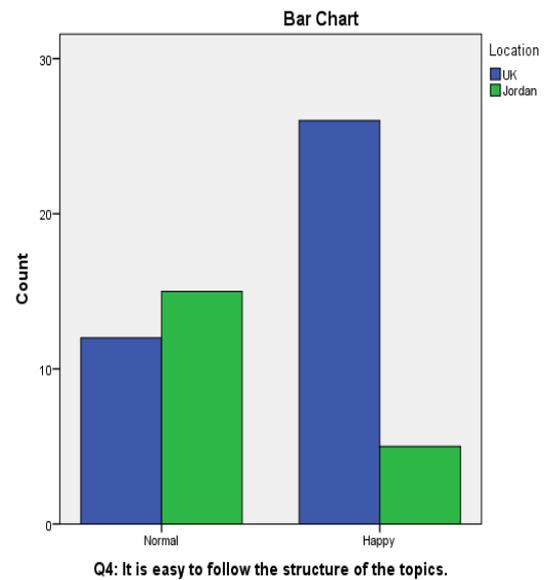


Table 8.65 Crosstab * Location – Q4

Figure 8.38 Q4 Between the Location Chart

Table 8.66 shows that there is not a significant difference (p value = 0.956 which is greater than .05) between the year group (year 5 and 6), when students rating this question.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi Square	.003 ^a	1	.956
Continuity Correction ^b	.000	1	1.000
Likelihood Ratio	.003	1	.956
Fisher's Exact Test			
Linear-by-Linear Association	.003	1	.957
N of Valid Cases	58		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 12.10. b. Computed only for a 2x2 table

Table 8.66 Chi-Square Test * Year Group – Q4

However, Table 8.67 illustrates that there is a slight difference in feeling between the student year groups when rating this question (with a percentage of 29.3% happy in year 6 in comparison with year 5, which was 24.1%). Figure 8.39 and Table 8.67 shows that there is no significant difference between the students who rated this question happy and with the students who find it neutral.

			Year Group		Total
			Year Five	Year Six	
Q4: It is easy to follow the structure of the topics.	Normal	Count	12	15	27
		% within Q4: It is easy to follow the structure of the topics.	44.4%	55.6%	100.0%
		% of Total	20.7%	25.9%	46.6%
	Happy	Count	14	17	31
		% within Q4: It is easy to follow the structure of the topics.	45.2%	54.8%	100.0%
		% of Total	24.1%	29.3%	53.4%
Total	Count	26	32	58	
	% within Q4: It is easy to follow the structure of the topics.	44.8%	55.2%	100.0%	
	% of Total	44.8%	55.2%	100.0%	

Table 8.67 Crosstab * Year Group -Q4

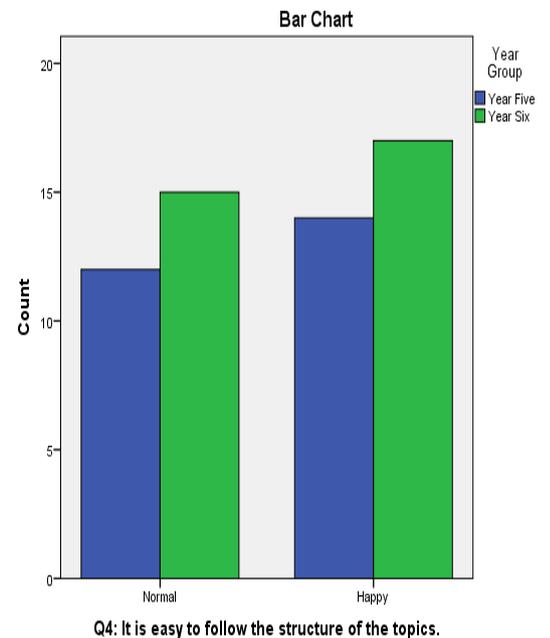


Figure 8.39 Q4 Between the Year Group Chart

Table 8.68 shows that there is not a significant difference (p value = 0.430 which is greater than .05) between the year group (year 5 and 6), when students rating this question.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.624 ^a	1	.430
Continuity Correction ^b	.277	1	.599
Likelihood Ratio	.625	1	.429
Fisher's Exact Test			
Linear-by-Linear Association	.613	1	.434
N of Valid Cases	58		

a. 0 cells (.0%) have expected count less than 5.

The minimum expected count is 13.50. b. Computed only for a 2x2 table

Table 8.68 Chi-Square Test * Gender - Q4

Table 8.69 and Figure 8.40 illustrates that there is a marginal difference in opinion between students when rating this question.

			Gender		Total
			Male	Female	
Q4: It is easy to follow the structure of the topics.	Normal	Count	12	15	27
		% within Q4: It is easy to follow the structure of the topics.	44.4%	55.6%	100.0%
		% of Total	20.7%	25.9%	46.6%
	Happy	Count	17	14	31
		% within Q4: It is easy to follow the structure of the topics.	54.8%	45.2%	100.0%
		% of Total	29.3%	24.1%	53.4%
Total	Count	29	29	58	
	% within Q4: It is easy to follow the structure of the topics.	50.0%	50.0%	100.0%	
	% of Total	50.0%	50.0%	100.0%	

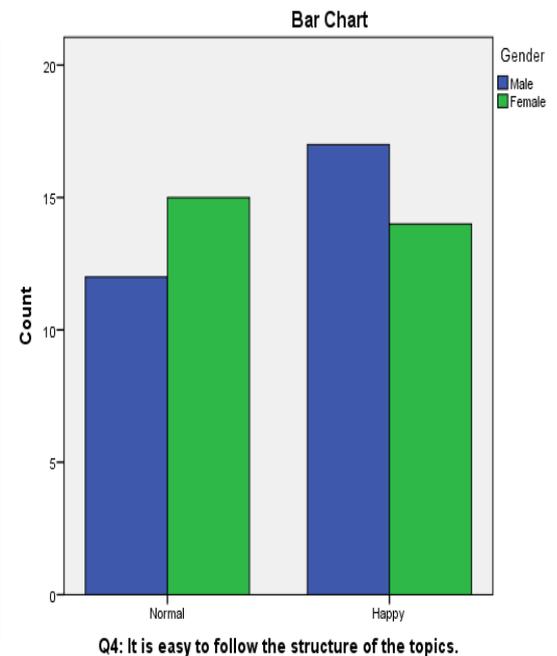


Table 8.69 Crosstab * Gender - Q4

Figure 8.40 Q4 Between the Gender Chart

It can be concluded from the students rating this question (Q4), that generally the students were happy with the way they have been taught the Islamic subjects. Although the Jordanian students were less positive toward the subject compared to their UK counterparts. This is because Islamic education is a high priority within the Jordanian curriculum, as Islam is the official religion in Jordan, which means that the subject taught by Abdullah ATA-CITS was not something new for the Jordanian students.

8.4.9. Experiment 3 (System Robustness) Discussion

Experiment 3 as specified in section (8.4.7), evaluated seven metrics related to hypothesis H3 (It is possible to develop a good quality Arabic CITS.).

During the tutoring session, Abdullah ATA-CITS recorded results into the log file; these results were used to measure and evaluate five metrics as follows:

1. Completion time, described in section (8.4.2.3).

2. Fired rules, described in section (8.4.8.2), shows that students feeling more confident when conversing in branch/fundamental 2 “to know your prophet”, with a percentage of 97.3% of rules that have been fired belonged to the current branch. However students feeling less confident when conversing in branch three “to know you God” (with a percentage of 86.3%), or when they converse in branch 1 “to know your religion” (with a percentage of 80.43%).
3. Rejected utterances, described in section (8.4.8.1), shows that the 2.85% of the total utterances were not belonged to the current topic, and 1.85% of the total utterances are rejected. Very little percentage (0.85%) for utterances not written in the Arabic language, or empty utterances with 0.15% percentage.
4. System Crashes, during this experiment (experiment 3), this system (Abdullah ATA-CITS), was never crashed, always answering the student’s questions as well as providing the tutorial contents.
5. Utterance not valid, described in section (8.4.8.1), shows that there are (97.15 %) of the utterances are belonged to the current topics of tutoring in Abdullah ATA-CITS. Very little percentages of utterances that not written in Arabic language (0.85%), empty (0.15%), and rejected utterances (1.85%).

The level of understanding during the tutoring session will be reflected in the completion time it takes the students to answer the questions, as well as the number of the rules that have been fired during the tutoring session that belong to the current branch. The results show that Abdullah ATA-CITS is able to lead the student through the tutoring session and is able to deal with different scenarios when the user does not follow the tutoring path.

Abdullah ATA-CITS is able to bring the user back to the current topic whenever the users stay away from the current tutoring topic. The results highlight the ability of Abdullah ATA-CITS to measure and adapt to different students level of knowledge. The system is also able to cope with the different behaviour of students and lead the conversation to the tutoring goal, with no crashes or delays. All these metrics and results signal the robustness of the implemented system.

Two questions/statements related to H3, were asked the students through questionnaires questions followed the tutoring session with Abdullah ATA-CITS. The first question “Do you remember what Abdullah the tutor has told you in the tutorial”, which is related to the quality of teaching. The results indicated that UK students are able to remember more what Abdullah ATA-CITS taught them in the tutoring session than Jordanian students with percentages of (51.7% for UK students, and 13.8% for Jordanian students).

The second statement, “It is easy to follow the structure of the topic”, which is related to quality of tutorial. The results obtained from students after rating this statement show that 53.4% of the whole sample is quite happy with the structure of the tutoring topics. 46.6% of the students expressed that they felt neutral about the tutoring structure.

8.5. EXPERIMENTS CONCLUSION

This chapter has described the experiments conducted to validate Abdullah ATA-CITS methodology and architecture proposed in Chapter 7. Three experiments studies have been conducted, on a sample of fifty-eight students from two different countries (UK and Jordan), and different school years (year 5, and year 6). The success of Abdullah ATA-CITS was evaluated by measuring the success of three hypotheses:

- **H1:** The success of students in a particular tutoring method is indicative of participant’s knowledge improvement in the taught subject.
- **H2:** It is possible to adapt to the student’s knowledge level from a tutoring discourse with an intelligent tutoring conversational agent.
- **H3:** It is possible to develop a good quality Arabic CITS.

Three main experiments were devised to test the above three hypotheses. The results all give significant evidence to support all the three hypotheses, and showed that Abdullah ATA-CITS was successful in tutoring the selected fundamental principles for target student age group (10-12 years old).

Abdullah ATA-CITS was able to gauge and adapt the different level of knowledge and behaviour of students. This supports H1 and proves that differing levels of students and knowledge and understanding can be accommodated into an ITS. By implementing different learning theories, and method (such as Gagne learning theory, Piaget learning theory, and storytelling learning method), which allow the ITS to change the tutoring content to suit individual learners needs which supports H2.

The results also demonstrate that the level of understanding and knowledge of a student can be measured through the tutoring conversation by measuring key metrics. These metrics allow the system to adapt the tutoring in order to make the content more suitable for the individual learner. From the gathered results, it can also be concluded that it is possible to design and develop an effective and robust Arabic CITS, which can deliver tutoring content and is able to converse with students in MSA and CAL. Thus, H3 can also be accepted.

CHAPTER 9 Conclusion and Future work**9.1. Introduction**

This chapter summarises the work and contributions according to the thesis goal and objectives, described in the first chapter. The suggestions and significance of the thesis are summarised. Finally, the possible directions of future work are presented.

9.2. Summary of Thesis

This research has presented a novel architecture and methodology for developing a conversational intelligent tutoring system called Abdullah CITS. The developed CITS aims to teach students the fundamentals of Islam allowing a conversational tutorial to take place in both modern and classical Arabic language. In chapter two, the Arabic language and its classification for both modern and classical Arabic language are reviewed, along with the impact of technology in Islamic education.

Chapter three presents the CAs and the different approaches that can be employed to develop CA, namely, natural language processing (NLP), pattern matching (PM), and sentence similarities measures (STS). The challenges for applying these approaches to the Arabic language are reviewed. Finally the reasons for selecting the pattern matching approach as the best approach to cope with the complexities, and morphological of the Arabic language.

Chapter 4 are describing the current state of Intelligent Tutoring Systems (ITS) research, and the methods used to model the learner's understanding of the topic and adapt the instruction accordingly. The benefits for combining the Arabic CA interfaces to the ITS were described concluding that there is no Arabic Conversational ITS (CITS), that can teach the Islamic topics.

However, the Abdullah CITS is the first Conversational ITS that can teach the Islamic topics in both modern and classical Arabic language for students aged 10-12 years old.

In relation to the main objective of this research which was, to design and develop an Arabic CITS and scripting language to teach children aged 10 to 12 years old the three fundamental principles of Islam. In order to test this research objective, firstly a prototype Arabic CITS architecture was developed. This involved research and development of language specific components that were utilised to create a novel Arabic CA and CITS architecture.

The main aim for the first prototype was to test whether or not the Arabic Language (MSA and CAL) could be successfully implemented into a CITS. The evaluation results of the first prototype showed that, it is indeed possible to implement the Arabic language into a CITS, which was validated through the results of the experiments.

The next stage of the research involved taking the prototype system, which was developed, in the first stage and adapting it to make it suitable to teach the target age group (10 – 12 year olds). The architecture of the first prototype was built upon through further research and development in order to enhance and improve the effectiveness of the system as a tutor as well as address the shortcoming brought to light through the first evaluation.

The major development of the second prototype system was the inclusion of learning theories and methods into the architecture. The intention behind this was to enable the system to detect the user's level of comprehension and be able to adapt the tutoring content and method to suit individual learners. This involved in-depth research into learning theories and how they are applied to different learning situations in order to improve the students learning experience. This led to the development of the tutor model which was implemented into the CITS architecture.

Moreover, the STS measure was developed further in order to make it more robust and accurate in matching with knowledge base resources (e.g. Islamic database). The knowledge base of the entire system was improved vastly to include more contexts and resources, through the implementation of additional Islamic educational resources such as Tafsir and context specific knowledge. Furthermore, the original scripting language and conversation manager were adapted to accommodate the learning theories into the architecture of the system.

The updated architecture formed the new system called Abdullah ATA-CITS. The new system was re-evaluated and validated through end user experiments, which were conducted in two different schools in two different countries with the target age group (10-12 years old). The results of the experiment carried out on the final system reveal that Abdullah ATA-CITS was able to mimic a real world Islamic Tutor.

This was shown in the results from the experiment where it was revealed that Abdullah ATA-CITS was able to measure the students level of knowledge and understanding through conversation related variables captured during runtime, and based on these variable adapt the tutoring method and content to suit individual learners/students. The success of the Abdullah ATA-CITS was also evident in the results of the pre-test and post-test scores. The pre-test and post-test scores reveals that the entire sample who interacted with the system achieved some degree of learning gain.

Additionally, the results also show that the system is able to successfully lead the students through a tutoring session while responding to context specific utterances appropriately. Furthermore, when a user exhibits behaviour or attitudes that are against the principles of Islam the Abdullah ATA-CITS is able to correct the user through appropriate response and wise Islamic advice. In contrast when a user exhibits good behaviour/attitude the Abdullah ATA-CITS responds appropriately through encouragement and reinforcement.

The Abdullah ATA-CITS also makes Islamic resources that were previously difficult to access by the younger age groups more accessible. The student can converse in MSA and the system is able to link the MSA utterances to appropriate CAL resources through the new STS (STS3) measure to support the responses delivered to the user.

The overall results indicate that the Abdullah ATA-CITS is successful in teaching the principles of Islam to the target age group, from this it can be concluded that the main research objective is achieved.

9.3. Summary of Contributions

The most important contribution of this thesis is to prove that it is possible to mimic an Islamic Arabic human teacher through dialog with an Arabic CITS. Other novel contributions of this thesis include:

1. A new CA and CITS knowledge base have been developed which is based on main authentic Islamic resources (the holy Quran, the Tafsir, Prophet's Muhammad Hadith, men around Prophet's Muhammad, and the noble woman's around Prophet's Muhammad). This knowledge base can be utilised by future researchers to create other software applications that can teach or be used as a reference for teaching (e.g. learning resources).
2. A novel Arabic CA framework that is based on the two major types of the Arabic language has been designed to process both MSA and CAL.
3. An Arabic Pattern Matching (PM) scripting language has been developed to handle user utterances written in MSA, and a novel short text similarity to extract the relevant responses using CAL.
4. Two novel Arabic prototype CITS and experimental results which successfully validate the architectures and methodologies for the creation of a CITS which dynamically personalises tutoring to individuals.
5. A novel framework has been devised which facilitates the implementation of learning theories/methods into a CITS, to personalize the learning to suit individual user's needs and abilities.

9.4. Future Work

Abdullah ATA-CITS is designed to teach the three fundamental principles of Islam to children aged (10-12 years old). However, the domain knowledge of Abdullah ATA-CITS can be extended through future work and research to:

- Teach much in deeper Islamic content such as the study of Islamic jurisprudence (Kamali, 2003).
- Teach different aged groups (12-18) which will target secondary school students, with more in depth Islamic topic and subjects.
- Further work could also involve the implementation of such a system in a distance-learning program to serve as a 24-hour Islamic tutor for real world Islamic education courses delivered in an academic environment.

This research could be continued in the future in many potential directions, such as the further development in the Arabic CA:

- Using the sentence similarity measures based on the Arabic WordNet is a possible direction for improving the quality of the Arabic CA once a suitable Arabic WordNet is available (i.e. classical Arabic language WordNet).
- Further research in the Arabic grammar in order to better classify the utterances. Possible approaches would be to include an Arabic Part of Speech (POS) tagger, in order to be able to reply with an appropriate responses to make the responses from the Arabic CA more suitable (Pasha et al., 2014).

Additionally this will enable to the CA to be able to detect and correct the grammar of the students, which will allow the students to speak in a more formal method (using CAL).

An interesting extension to this work would be to extend the conversational user interface to include other forms, such as a spoken interface:

- The addition of voice recognition and feedback into Abdullah ATA-CITS could further mimic human tutoring, improving flexibility and extend the learning process, especially for younger children. The verbal communication method will also make the system more accessible to more people, for example disabled people who cannot use a keyboard to type utterances.
- Abdullah ATA-CITS, can be designed and developed as a mobile CITS, which can provide an intelligent tutoring conversation through mobile/tablet devices. This will also increase the accessibility of Abdullah ATA-CITS making it available to more people.

Another possible avenue for further research would entail the inclusion of more learning theories into the Abdullah ATA-CITS. The learning theories currently implemented into the Abdullah ATA-CITS are learning theories related to managing and directing the tutoring session and students. This architecture can be further developed by including more learning theories, method and styles that are specific to language learning and improvement (Rodgers, 2014). This will enhance the CITS architecture further at teaching the CAL and related subjects.

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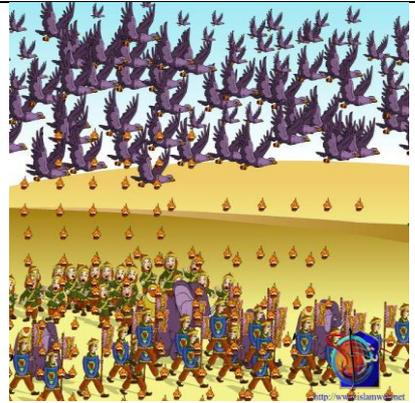
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APPENDICES

Appendix 1: Tutoring Dialogue (Original Arabic Dialogue)

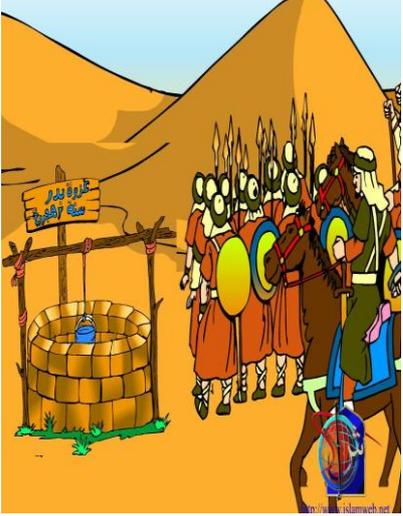
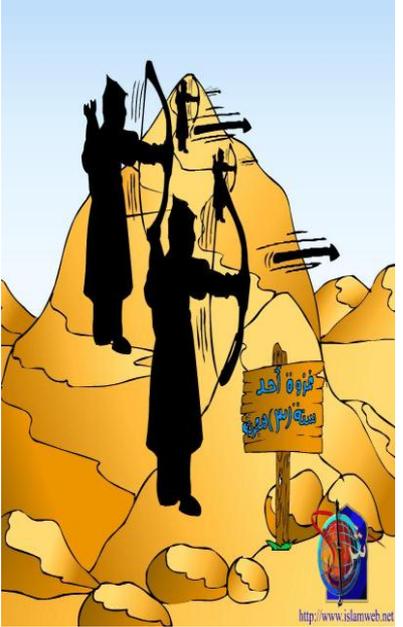
Dialogue 1 (About The Prophet Muhammad)

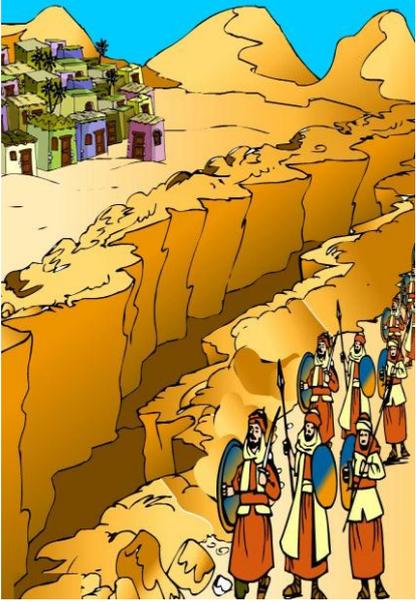
User	Abdullah CITS
Name is: مريم M/F: F	مرحبا بك اختي الكريمة مريم , نتحدث انشاء الله عن الرسول محمد صلى الله عليه وسلم . هل تعلمين في أي مدينة ولد ؟
Answer مكة المكرمة	احسنت ولد محمد صلى الله عليه وسلم في عام الفيل بمكة لماذا هذا الاسم "الفيل" ؟
Answer استخدام الفيل	أنا اعتقد بأن الاجابة المثلى هي الكعبة المشرفة هي بيت الله في الأرض بناها من قديم الزمان سيدنا إبراهيم وابنه إسماعيل عليهما السلام وقد أحبها العرب وعظموها .. فيقصدونها في الحج .. يطوفون بها ولا يرون لها بديل وفي قديم الزمان... سمع عنها مجرم اسمه أبرهة الأشرم قرر أن يبني [مبنى] في اليمن. ليصرف الناس عن الكعبة وبنى المبنى .. فلم يأت أحد من الناس إلا النصرى فقرر أن يهدم الكعبة كيف اراد أبرهة هدم الكعبة ؟
Answer استخدام الفيل	أنا اعتقد بأن الاجابة المثلى هي استعان ابرهة بجيش كبير تتقدمهم الاقبال ويريدون هدم الكعبة هل هدم ابرهة الكعبة ؟
Answer لا	احسنت بارك الله فيك لم يستطع ابرهة وجنوده هدم الكعبة وأرسل الله عليهم طيوراً مع كل طائر حجر يحمله فترميه بها . فتخرق رؤوسهم .. فماتوا وهرب منهم من هرب. وسلم الله الكعبة وحمي بيته من هذا المجرم. وسمي هذا العام بعام الفيل وفيه ولد سيد الكائنات محمد صلى الله عليه وسلم وَأَرْسَلَ عَلَيْهِمْ طَيْرًا أَبَابِيلَ ثُمَّ وَعَدَّمَا بَلَّغَ الرَّسُولَ خَمْسًا وَثَلَاثِينَ سَنَةً مِنْ عَمْرِهِ عند اعادة بناء الكعبة وضع الرسول الحجر الاسود على ثوبه وطلب أن تأخذ كل عشيرة بناحية من الثوب لماذا ؟



<p>لتشارك كل القبائل</p>	<p>أنا اعتقد بأن الاجابة المثلى هي رأت قريش إعادة بناء الكعبة . فأخذت كل جماعة منها تتولى بناء الجزء الذي خصص لها وظل الجميع يعمل حتى بلغ البناء موضع الحجر الأسود وهنا اختلفت العشائر فيمن يضع الحجر الأسود في موضعه وكاد الخلاف أن يؤدي إلى نزاع دموي لولا أن اقترح أبو أمية بن المغيرة أن يجعلوا بينهم حكماً أول داخل عليهم , وكان الرسول عليه الصلاة والسلام أول داخل ، فلمَّا رأوه قالوا: هذا الأمين، رضينا به حكماً. فبسط الرسول عليه الصلاة والسلام ثوب على الأرض، ثم وضع عليه الحجر الأسود وطلب أن تأخذ كل عشيرة بناحية من الثوب ثم يرفعهوه جميعاً ففعلوا، ولمَّا بلغوا موضعه تناول الرسول عليه الصلاة والسلام الحجر بيديه الشريفتين ثم وضعه في مكانه. وبذلك حسم الخلاف بين قريش وأرضاهم جميعاً</p> <p>عندما كان محمد صلى الله عليه وسلم في الغار امره جبريل بقراءة آيات من أي سورة</p>	
<p>العلق</p>	<p>احسنت أن أول ما نزل من القرآن هي سورة العلق . ثم بدأ النبي صلى الله عليه وسلم بالدعوة الى عبادة الله وحده قال تعالى اقرأ باسم ربك الذي خلق</p> <p>عند بداية الاسلام هل كان المسلمون يعبدون الله علنا امام الكفار أم سرا بدون ان يراهم أحد؟</p>	
<p>سرا</p>	<p>احسنت بارك الله فيك بدأ الرسول دعوته سرا ، وأسلم معه من أسلم من أشرف قريش ومن الضعفاء والفقراء ، واستمر الحال سرا ثلاث سنين</p> <p>بعد ان استمرت الدعوة سرا لمدة ثلاث سنين , بماذا امر الله رسوله محمد صلى الله عليه وسلم ؟</p>	
<p>الدعوة جهرا</p>	<p>احسنت بارك الله فيك أمر "الله" تعالى رسوله الكريم أن يعلن دعوته ويجهر بها ، وأن يصدع بأمر الإسلام ، وأن ينذر عشيرته الأقربين قريش قال اللع تعالى وَأَنْذِرْ عَشِيرَتَكَ الْأَقْرَبِينَ هل تعلم ماذا قال الكفار على محمد صلى الله عليه وسلم ؟</p>	
<p>اتهم بالجنون</p>	<p>أنا اعتقد بأن الاجابة المثلى هي بدأ الكفار يؤذون الرسول صلى الله عليه وسلم ويسبونونه ، فمرة يتهمونه بالساحر ومرة يتهمونه بالكاذب ومرة يتهمونه بالمجنون ومرة يتهمونه بالشاعر أم يَقُولُونَ شَاعِرٌ نَتَرَبِّصُ بِهِ رَبَّيَ الْمُتُونِ هل تعلم بماذا امر الله سبحانه وتعالى محمد صلى الله عليه وسلم ؟</p>	

<p>الهجرة Answer</p>	<p>احسنت بارك الله فيك أمر الرسول أصحابه بأن يهاجروا إلى الحبشة لأن فيها ملك عادل يسمى " النجاشي " ، فخرج المسلمون إلى الحبشة في حماية الملك النجاشي وكان عددهم ثلاثة وثمانين هل توقف ابناء المشركين لمحمد صلى الله عليه وسلم والى أين امرهم بالهجرة بعد الحبشة ؟</p>	
<p>لا ثم Answer هاجروا الي المدينة</p>	<p>احسنت بارك الله فيك خرج رسول الله صلى الله عليه وسلم، في الظهيرة ، حين يستريح الناس في بيوتهم، وإلى بيت أبي بكر الصديق رضي الله عنه وأبرم معه أمور الهجرة , وكان من عادة الرسول الله أن ينام في أوائل الليل بعد صلاة العشاء ، ويخرج في النصف الأخير من الليل إلى المسجد الحرام ، فأضجع علياً على فراشه تلك الليلة ، وأخبره بأنه لا يصيبه مكروه ، فلما نام عامة الناس وهدأ الليل جاء المتآمرون سراً إلى بيت رسول الله وطوقوه ، ورأوا على بن أبي طالب نائماً على فراشه وخرج رسول الله من بيته وهم مطوقون به ، فذر تراب البطحاء على رؤوسهم ، وهو يتلو قوله سبحانه وتعالى وَجَعَلْنَا مِنْ بَيْنِ أَيْدِيهِمْ سَدًّا وَمِنْ خَلْفِهِمْ سَدًّا فَأَعْسَيْنَاهُمْ فَهُمْ لَا يُبْصِرُونَ ثم وبعد ذلك قرر الرسول صلى الله بالهجرة الي المدينة برفقة صاحبه أبي بكر فهل سار مباشرة باتجاه المدينة ؟</p>	
<p>لا Answer</p>	<p>احسنت بارك الله فيك أنطلق رسول الله برفقة أبي بكر الصديق سرا باتجاه غار ثور قبل بزوغ الفجر ، على بعد نحو خمسة أميال في اتجاه اليمن هل تعلم كم ليلة مكث رسول الله مع أبي بكر في الغار ؟</p>	
<p>ثلاث ليال Answer</p>	<p>احسنت بارك الله فيك مكث الرسول في الغار ثلاث ليال وقد وصلوا المشركين إلى باب الغار بحيث لو طأطأ أحدهم رأسه ونظر إلى قدميه لرأهما . حتى اشتد حزن أبي بكر على رسول الله فقال : ما ظنك يا أبو بكر باثنين الله ثالثهما . لا تحزن إن الله معنا . ثم اتجها نحو المدينة ، وقد زحف الناس للاستقبال ، وارتجت البيوت بالتحميد والتقدير ، وخرج النساء والصبيان يقطن : طلوع البدر علينا من ثنيات الوداع وجب الشكر علينا ما دعانا الله داع أيها المبعوث فينا جنت بالمر المطاع ولاكن قریش أستمرت بحربها على رسول الله ,</p>	

	<p>ثم حدثت أول معركة بين المسلمين والكفار أتعلم ما هي؟</p>	
<p>Answer بدر</p>	<p>احسنت بارك الله فيك غزوة بدر : وقعت هذه الغزوة في السنة (17) من رمضان من السنة الثانية للهجرة عند بئر "بدر" الذي يقع بين مكة والمدينة حيث اعترض المسلمون قافلة أبي سفيان القادمة من الشام ، وكان السبب الذي دفع المسلمون لاعتراض القافلة هو استرجاع أموالهم التي نهبتهم قريش قبل وأثناء هجرتهم إلى المدينة . علمت قريش بأن المسلمين قد هجموا على قافلتهم ، فأخذ أهلها يعدون أنفسهم ، ويجمعون أسلحتهم استعداداً لحرب المسلمين. وكان عدد المسلمين في هذه الغزوة (314) رجلاً من المهاجرين والأنصار، في حين كان جيش "قريش" يقترب من الألف . هذا وقد أكرم الله سبحانه وتعالى رسوله والمؤمنين بالنصر على المشركين فهل استسلمت قريش . وما هي الغزوة الثانية؟</p>	
<p>Answer احد</p>	<p>احسنت بارك الله فيك غزوة احد : وقعت أحداث هذه الغزوة في شهر شوال من العام الثالث للهجرة عند جبل "أحد" الواقع شمالي "المدينة" ، وكانت "قريش" قد جندت ثلاثة آلاف من رجالها للانتقام من المسلمين، والثأر لهزيمتها الساحقة في "بدر"، وعندما وصلت أخبار هذا الاستعداد للنبي - صلى الله عليه وسلم خرج بجيشه إلى ساحة "أحد"، وجعل ظهر جيشه إلى الجبل والأعداء أمامه ، وأمر خمسين رجلاً ممن يحسنون الرمي بالنبل بالصعود إلى قمة عالية خلف ظهر جيش المسلمين، وأوصاهم بالأبتركون مواقعهم، سواء انتصر المسلمون أو انهزموا . ودارت المعركة وحقق المسلمون النصر في البداية وظنوا أن المعركة قد انتهت فانشغلوا بجمع الغنائم التي خلفها المشركون المنهزمون ، وفي الوقت نفسه خالف الرماة الذين فوق الجبل أمر النبي-صلى الله عليه وسلم- فتركوا مواقعهم ونزلوا؛ ليكون لهم نصيب في جمع الغنائم . ولما رأى المشركون ذلك تقدم "خالد بن الوليد"- قبل إسلامه- وجاء من الخلف، وانقض على المسلمين مستغلاً ترك الرماة مواقعهم ، وارتبك المسلمون من هول المفاجأة ، واضطربت صفوفهم ، وجرح الرسول في المعركة، وانتهى الأمر بهزيمة المسلمين، وسقوط واحد وسبعين شهيداً ، وأخذ المسلمون درساً غالياً لمخالفتهم أوامر الرسول - صلى الله عليه وسلم . ثم وبعد ذلك حدثت معركة فاصلة أخيرة بين المسلمين وكفار قريش أتعلم ما هي؟</p>	

<p>الخندق Answer</p>	<p>الإجابة المثلى هي غزوة الأحزاب أو غزوة الخندق : وقعت أحداث هذه الغزوة في العام الخامس للهجرة؛ حيث تحالف المشركون من "قريش" وقبائل "غطفان" و"بنى أسد" لمحاربة المسلمين ، وتجمع لهم جيش من عشرة آلاف مقاتل، وتقدموا إلى "المدينة" للقضاء على المسلمين. ولما علم المسلمون بهذه الأخبار تحصنوا داخل "المدينة"، وحفروا خندقًا من الجهة الشمالية الغربية من "المدينة" لمنع اقتحام جيوش الأحزاب. وصاحب فكرة حفر الخندق هو الصحابي الجليل "سلمان الفارسي" ولما جاءت جيوش الأحزاب فوجئت بالخندق، وعجزت عن اقتحامه؛ ثم أرسل الله ريحًا شديدة قلعت خيام المشركين ، وانقلب الموقف كله بفضل الله تعالى ، وأدرك "أبو سفيان بن حرب" قائد الأحزاب أنه لا فائدة من البقاء ، فأمر الأحزاب بالرحيل ، والعودة من حيث جاءوا، وبعد رحيل الأحزاب قال النبي - صلى الله عليه وسلم- : "الآن نغزوهم ولا يغزونا أي أن "قريشًا" لن تستطيع مهاجمة "المدينة" مرة أخرى . قال الله تعالى يَا أَيُّهَا الَّذِينَ آمَنُوا اذْكُرُوا نِعْمَةَ اللَّهِ عَلَيْكُمْ إِذْ جَاءَكُمْ جُنُودٌ فَأَرْسَلْنَا عَلَيْهِمْ رِيحًا وَجُنُودًا لَمْ تَرَوْهَا وَكَانَ اللَّهُ بِمَا تَعْمَلُونَ بَصِيرًا</p> <p>ثم وبعد هذه المعركة العظيمة من الله على المسلمين بنصر وفتح عظيم ، أتعلم أي نصر وفتح هذا ؟</p>	
<p>فتح مكة Answer</p>	<p>احسنت بارك الله فيك فتح مكة : قرر النبي -صلى الله عليه وسلم- فتح "مكة" ، فخرج على رأس جيش قوامه عشرة آلاف ، وذلك في بداية الأسبوع الثاني من شهر رمضان من العام الثامن للهجرة . ودخل النبي - صلى الله عليه وسلم - "مكة" فاتحًا منتصرًا وهو الذي خرج منها متخفيًا من ثماني سنوات مضت، بعد أن تأمرت عليه "قريش" لقتله ، فلما انتهى من الطواف حول الكعبة جمع أهل "مكة"، وقال لهم : ما تظنون أنى فاعل بكم ؟ قالوا خيرًا أخ كريم وابن أخ كريم، فقال لهم: "اذهبوا فأنتم الطلقاء". وبهذا ضرب النبي - صلى الله عليه وسلم- أروع الأمثلة في السماحة والعفو عند المقدرة، وكان في استطاعته أن يثار ممن ظلمه وأساء إليه وإلى أصحابه، وساموهم سوء العذاب ، لكنه لم يفعل ! وَقُلْ جَاءَ الْحَقُّ وَرَهَقَ الْبَاطِلُ إِنَّ الْبَاطِلَ كَانَ زَهُوقًا انتهى</p>	

Dialogue 2 (To know your religious)

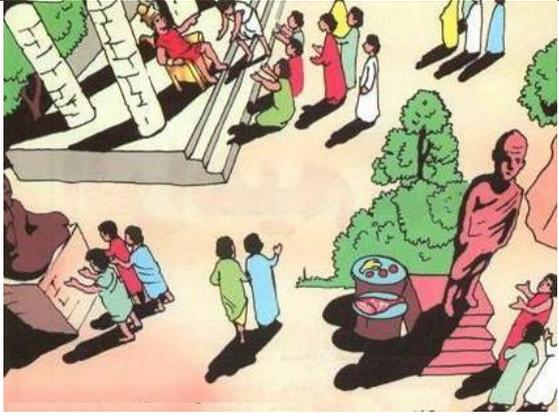
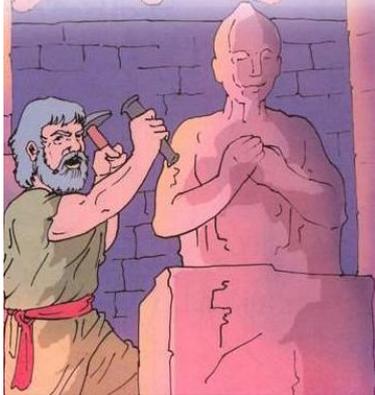
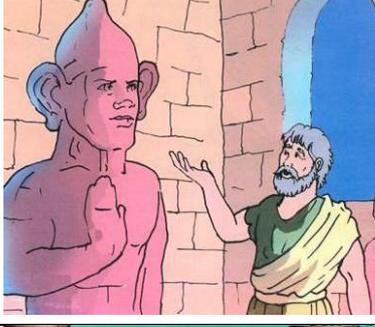
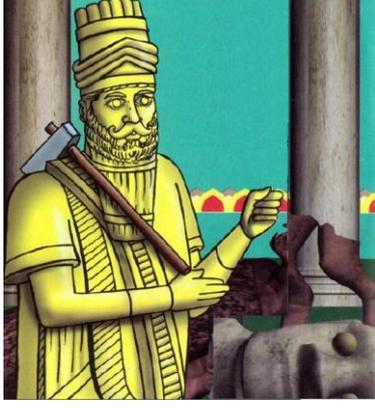
User	Abdullah CITS
Answer لا	<p>احسنت بارك الله فيك ويبدأ شهر رمضان بثبوت رؤية الهلال بعد غروب اليوم التاسع والعشرين من شهر شعبان، فإذا لم يظهر الهلال أتممنا شهر شعبان ثلاثين يوماً . في هذا الشهر يستحب السحور هل تعلم لماذا؟</p> 
Answer لان فيها البركة	<p>احسنت بارك الله فيك السحور، ووقته قبل طلوع الفجر، وهو يقوي الصائم وينشطه، ويهون عليه مشقة الصوم، بقي ركن واحد عظيم عند الله هل تعلم ما هو؟</p> 
Question ما هو الاصل الثاني	<p>انا اسف , ولأكني لا اعرف الاجابة</p>
Question من هو نبيي	<p>انا اسف , ولأكني لا اعرف الاجابة ما رأيك بالرجوع الى موضوعنا الاصيلي</p>
Question من هو محمد	<p>محمد صلى الله عليه وسلم ما كَانَ مُحَمَّدٌ أَبَا أَحَدٍ مِنْ رِجَالِكُمْ وَلَكِنْ رَسُولَ اللَّهِ وَخَاتَمَ النَّبِيِّينَ وَكَانَ اللَّهُ بِكُلِّ شَيْءٍ عَلِيمًا بقي ركن واحد عظيم عند الله هل تعلم ما هو؟</p>
Answer الحج	<p>احسنت بارك الله فيك الحج هو الركن الخامس من أركان الإسلام، فرضه الله - تعالى - على المسلمين مرة واحدة في العمر، وتؤدي هذه الفريضة في شهر ذي الحجة. فيه آياتٌ بَيِّنَاتٌ مَقَامُ إِبْرَاهِيمَ وَمَنْ دَخَلَهُ كَانَ آمِنًا وَاللَّهُ عَلَى النَّاسِ حَجُّ الْبَيْتِ مَنْ اسْتَطَاعَ إِلَيْهِ سَبِيلًا وَمَنْ كَفَرَ فَإِنَّ اللَّهَ غَنِيٌّ عَنِ الْعَالَمِينَ هل تعلم ما هي</p> 

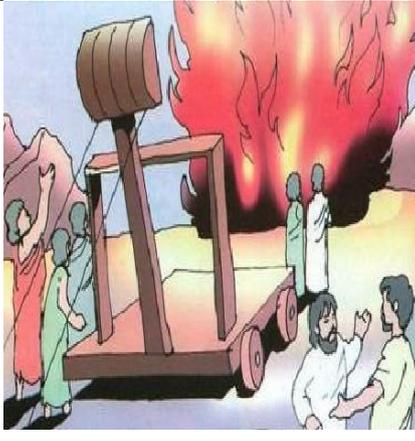
<p>Don't Know Answer لا اعرف</p>	<p>منافع الحج؟ الحج من أعظم الأعمال التي يتقرب بها المسلم إلى ربه؛ لأن الله- تعالى- يغفر به الذنوب، كما أن الحج يطهر الحجاج من الذنوب ، وأما المنافع الدنيوية، فيعد موسم الحج لقاء سنوياً للمسلمين من شتى أقطار الأرض، يجتمعون فيه ليتشاوروا فيما بينهم ويتعاونوا على البر والتقوى. الحاج يجب ان يقوم بأشياء كثيرة تسمى المناسك ، هل تستطيع اخباري بواحدة فقط؟</p>	
<p>Answer الطواف</p>	<p>احسنت ، المناسك هي: الإحرام والنية، عندما يريد المسلم أداء فريضة الحج يختار لذلك ما لا حلالاً، ويجدد التوبة من ذنوبه 2 طواف القدوم إذا وصل الحاج إلى "مكة" توجه للطواف حول الكعبة، 3 بعد الطواف يذهب الحاج إلى المسعى، السعي بين "الصفاء" و"المروة" 4 في صباح اليوم الثامن من ذي الحجة المعروف بيوم التروية، يتوجه الحاج إلى "منى" للمبيت بها 5 الوقوف بعرفة 6 بعد غروب شمس يوم التاسع من ذي الحجة يتوجه الحاج إلى مزدلفة، هل تعلم ما هو الركن الاعظم؟</p>	
<p>Answer الوقوف بعرفة</p>	<p>احسنت بارك الله فيك الوقوف بعرفه ركن من أركان الحج، لا يصح الحج إلا به، وعلى الحاج أن يتوجه إلى عرفة بعد طلوع شمس اليوم التاسع من ذي الحجة، ويفضل الله في يوم عرفة على عباده الذين سعوا في مرضاته، ويشهد ملائكته أنه قد غفر لمن شهد عرفة . هذه هي أركان الاسلام ، فما هو الايمان؟</p>	

Dialogue 3 (to know your God)

User	Abdullah CITS	
Answer الله	من ربك؟	
Answer لا اعرف	احسنت بارك الله فيك ربي الله الذي رباني وربى جميع العالمين بنعمه وهو معبودي ليس لى معبود سواه والدليل قوله تعالى: الْحَمْدُ لِلَّهِ رَبِّ الْعَالَمِينَ ما معنى الرب؟	
Answer لا اعرف	المالك المعبود المتصرف وهو المستحق للعبادة بم عرفت ربك؟	
Answer المخلوقات	أعرفه بآياته ومخلوقاته، ومن آياته الليل والنهار والشمس والقمر، ومن مخلوقاته السماوات السبع ومن فيهن والأرضون السبع ومن فيهن وما بينهما، والدليل قوله تعالى: وَمِنْ آيَاتِهِ اللَّيْلُ وَالنَّهَارُ وَالشَّمْسُ وَالْقَمَرُ لَا تَسْجُدُوا لِلشَّمْسِ وَلَا لِلْقَمَرِ وَاسْجُدُوا لِلَّهِ الَّذِي خَلَقَهُنَّ إِنْ كُنْتُمْ إِيَّاهُ تَعْبُدُونَ ما المقصود بآيات الله؟	
Question الله خلقنا	احسنت بارك الله فيك أعرف ربي بآياته ومخلوقاته، ونعمه على الانسان ومن مخلوقات الله؟	
Answer الانسان	من ايات الله الليل والنهار والشمس والقمر ما المقصود بمخلوقات الله؟	
Answer الصحة	الله خالق كل شئ ومن مخلوقاته السماوات والارض ما هي نعم الله علينا؟	
Answer لا اعرف	احسنت بارك الله فيك نعمة الصحة والعافية هل تعلم ما هو الطاعوت؟	

Appendix 1: Tutoring Dialogue (Original Arabic Dialogue)

<p>Answer كان ساحر</p>	<p>الطاغوت كلمة مشتقة من الطغيان وهو مجاوزة الحد . ومن الامثلة الرائعة قصة ابراهيم ولد ابراهيم عليه السلام في قوم لا يؤمنون بوحداية الله تعالى , بل لم يجتمع قوم ابراهيم على عبادة اله واحد , فمنهم من كان يعبد الاصنام والتمائيل المصنوعة من الحجر والخشب ومنهم من يعبد الكواكب والشمس والقمر , وطائفة ثالثة تعبد الحكام من دون الله , وهل تعلم ما كانت مهنة والد ابراهيم عليه السلام؟</p>	
<p>Answer لا لايعبها</p>	<p>في هذا المجتمع ولد ابراهيم , وكان والد ابراهيم اشهر صانع للتمائيل والاصنام , هل كان ابراهيم يحب هذه الاصنام؟</p>	
<p>Answer لا اعرف</p>	<p>احسنت , سأل ابراهيم اباه يوما , أي تمثال هذا ان اذناه كبيرتان , قال ابوه أنه رب الارباب , وهذه الاذنان الكبيرتان ترمز الى فهمه العميق. ضحك ابراهيم بينه وبين نفسه. ثم قرر البدء بالدعوة هل تعلم بماذا بدء؟</p>	
<p>Answer لا</p>	<p>أنهم عبدة الاصنام , خرج ابراهيم من البيت وكان يعرف بأن هناك احتفال كبيرا يقام على الطرف الثاني من المدينة , فدخل الى المعبد فوجد الطعام امام الاصنام فقال لهم ساخرا ألا تأكلون؟ ما لكم لا تتنطقون ثم هوى بفأسه على الاصنام وكسرها الى قطع صغيرة . ألا صنم واحد لم يكسره وجعل الفأس في عنقه كي يسأله عن فعل ذلك , فهل تكلمت الاصنام؟</p>	

<p>لا Answer</p>	<p>احسنت ولما ذهب القوم الى المعبد وجدوا الاصنام كلها محطمة , فأحضروا ابراهيم وسألوه أنت فعلت هذا بالهتنا ؟ فأشار ابراهيم الى الصنم الكبير وقال :بل فعله كبيرهم فسألوهم ان كانوا ينطقون ! فقال قومه لقد علمت يا ابراهيم ان هذه الاصنام لا تتكلم فكيف نسألها . فقال لهم ابراهيم فكيف اذا تعبدون اصنام لا تتكلم ولا تدافع عن نفسها . فقرر قومه بأن يحرقوه , هل تعلم ماذا حدث بابراهيم عليه السلام ؟</p>	
<p>الصلاة Answer</p>	<p>وحفر له قومه حفرة عميقة وأشعلوا فيها النار وألقوا ابراهيم فيها ولاكن الله سبحانه وتعالى انجاه من النار , ونصره على المشركين. بأي شيء أمرك الله به ؟</p>	
	<p>أمرني بالتوحيد ونهاني عن الشرك. ودليل الأمر قوله تعالى ﴿إِنَّ اللَّهَ يَأْمُرُ بِالْعَدْلِ وَالْإِحْسَانِ وَإِيتَاءِ ذِي الْقُرْبَىٰ وَيَنْهَىٰ عَنِ الْفَحْشَاءِ وَالْمُنْكَرِ وَالْبَغْيِ</p>	

Appendix 2: Tutoring Dialogue (Translated Version)

Dialogue 1

1-Abdullah: Welcome to Abdullah the tutor, please write your name

2-User: my name is Mariam

3-Abdullah: **Dear sister Mariam** welcome to the program, do you like to converse about the prophet Muhammad? *Do you know where he is born?*

4-Mariam: Makah

5-Abdullah: **excellent**, Muhammad (peace be upon him) born in The Year of the Elephant in Makah. *What is the secret beyond this name the elephant?*

6-Mariam: Abraha wish to demolish Kaaba

7-Abdullah: **excellent**, Abraha, the ruler of Yemen, marched upon the Kaaba with a large army, which included elephants, intending to demolish it. *So does the army demolish the Kaaba?*

8-Mariam: No they can't

9-Abdullah: **Good**, the elephant is said to have stopped at the boundary around Mecca, and refused to enter (**Quran:** Have you not considered, [O Muhammad], how your Lord dealt with the companions of the elephant? (1) Did He not make their plan into misguidance?), *do you know The First Verse of the Qur'an?*

10-Mariam: The Verse of the Al-Fatiha

11-Abdullah: **I think the right answer is**, the Verse of Al-Alaq (**Quran:** Recite in the name of your Lord who created - (1) Created man from a clinging substance. (2)). *do you know how the beginning proselytizing or preaching of Islam was?*

12-Mariam: Secret

13-Abdullah: **excellent**, Muslims worship first years of Islam in a secret way. *Do you know where is the prophet going?*

14-Mariam: Kaf, Ha, Ya, 'Ayn, Sad.

15-Abdullah: **Quran** ([This is] a mention of the mercy of your Lord to His servant Zechariah), *can you please answer my question (Do you know where is the prophet going?)*

16-Mariam: who's Hinduism?

17-Abdullah: Hinduism is the predominant religion of the Indian. *Can you please answer my question (Do you know where the prophet is going?)*

18-Mariam: to al Madina

19-Abdullah: **excellent**, In 622, Muhammad and around 70 Meccan believers left Mecca for sanctuary in al Madina. *Do you know what the first battle in Islam was?*

20-Mariam: the battle of Badr

21-Abdullah: **excellent God bless you**, The Battle of Badr was a key battle in the early days of Islam. *Do you know what was the second battle in Islam?*

22-Mariam: the Battle of Hunayn

23-Abdullah: The Battle of Hunayn was fought between Muhammad and his followers against the Bedouin tribe of Hawazin. *Can you please answer my question (Do you know what the second battle in Islam was?)*

24-Mariam: I don't know

25-Abdullah: The Battle of Uhud, in 625, Abu Sufyan ibn Harb, King of Mecca. Once again led a Meccan force against Medina. *What was the next battle after Uhud?*

26-Mariam: Battle of the Confederates

27-Abdullah: **excellent God bless you**, Battle of the Trench or (Battle of the Confederates) the battle that was Surrounding Medina in 627, and the results Decisive Muslim victory, During these battles God helps Muslims by angels whose they fight with against non-Muslims. *What was the last battle during the prophet period?*

28-Mariam: I don't like angels

29-Abdullah: **Dear Mariam be careful**, God says in **Quran** (Whoever is an enemy to Allah and His angels and His messengers and Gabriel and Michael - then indeed, Allah is an enemy to the disbelievers.), *can you please answer my question (what was the last battle during the prophet period?)*

30-Mariam: Conquest of Mecca

31-Abdullah: **excellent God bless you**, Mecca was conquered by Muslims on 11 December 629 AD

Dialogue 2

1-Abdullah: Welcome to Abdullah the tutor, please write your name

2-User: my name is Faz

3-Abdullah: Dear sister Faz welcome to the program, do you like to converse about the prophet Muhammed? *Do you know where he is born?*

4-Faz: Makah

5-Abdullah: excellent, Muhammed (peace be upon him) born in The Year of the Elephant in Makah. *What is the secret beyond this name the elephant?*

6-Faz: I don't know.

7-Abdullah: Abraha, the ruler of Yemen, marched upon the Kaaba with a large army, which included elephants, intending to demolish it. *So does the army demolish the Kaaba?*

8-Faz: Perhaps

9-Abdullah: Perhaps those who disbelieve will wish that they had been Muslims (Quran). *So does the army demolish the Kaaba?*

10-Faz: Yes

11-Abdullah: the elephant is said to have stopped at the boundary around Mecca, and refused to enter (Quran: Have you not considered, [O Muhammad], how your Lord dealt with the companions of the elephant? (1) Did He not make their plan into misguidance?), *do you know The First Verse of the Qur'an?*

10-Faz: The Verse of the Al-Nas

11-Abdullah: I think the right answer is, the Verse of Al-Alaq (Quran: Recite in the name of your Lord who created - (1) Created man from a clinging substance. (2)). *do you know how the beginning proselytizing or preaching of Islam was?*

12-Faz: I think publicly

13-Abdullah: Muslims worship first years of Islam in a secret way. *Do you know where is the prophet going?*

14-Abdullah: You tell me.

15-Abdullah: In 622, Muhammad and around 70 Meccan believers left Mecca for sanctuary in al Madina. *Do you know what the first battle in Islam was?*

Dialogue 3

1-Abdullah: Welcome to Abdullah the tutor, please write your name

2-User: my name is Tarq

3-Abdullah: Dear brother Tarq welcome to the program, do you like to converse about the greatest thing in the presence? *Can you tell me one of the ninety nine names of Allah?*

4-Tarq: The Subduer

5-Abdullah: excellent, *do you know what is meant by the signs of God?*

6-Tarq: God's power

7-Abdullah: excellent God bless you. Signs in Arabic language is the sign and significance, and in Quran

Signs came with several meanings, including verses of the mark and the lesson and argument and evidence and proof. *Sun it's an example of the God signs, can you give another example?*

8-Tarq: Can be Moon

9-Abdullah: excellent, Many signs of God, such as night, day, the sun and the moon. (Quran: And of His signs are the night and day and the sun and moon. Do not prostrate to the sun or to the moon, but prostrate to Allah, who created them, if it should be Him that you worship.) *God the Creator of everything, and have many graces on us can you give an example?*

10-Tarq: the prayer

11- Abdullah: God mentioned five prayers in a day. *God the Creator of everything, and have many graces on us can you give an example?*

Dialogue 4

1-Abdullah: Welcome to Abdullah the tutor, please write your name

2-User: my name is Ahmed

3-Abdullah: **Dear brother Ahmed** welcome to the program, do you like to converse about the prophet Muhammad *Do you know where he is born?*

4- Ahmed: The holy Makah

5-Abdullah: **excellent,** Muhammad (pace be upon him) born in The Year of the Elephant in Makah *.What is the secret beyond this name the elephant?*

6- Ahmed: they use elephant

7-Abdullah: **Good,** Abraha, the ruler of Yemen, marched upon the Kaaba with a large army, which included elephants, intending to demolish it. *So does the army demolish the Kaaba?*

8- Ahmed: No

9-Abdullah: **Good,** the elephant is said to have stopped at the boundary around Mecca, and refused to enter (**Quran:** Have you not considered, [O Muhammad], how your Lord dealt with the companions of the elephant? (1) Did He not make their plan into misguidance?), *do you know The First Verse of the Qur'an?*

10- Ahmed: Al-Alaq

11-Abdullah: **excellent,** the Verse of Al-Alaq (**Quran:** Recite in the name of your Lord who created - (1) Created man from a clinging substance. (2)). *do you know how the beginning proselytizing or preaching of Islam was?*

12- Ahmed: Secret

13-Abdullah: **excellent,** Muslims worship first years of Islam in a secret way. *Do you know where is the prophet going?*

14- Ahmed: Al Madina

15-Abdullah: **excellent,** In 622, Muhammad and around 70 Meccan believers left Mecca for sanctuary in al Madina. *Do you know what the first battle in Islam was?*

16- Ahmed: How many days did Prophet Muhammad and Abu Bakr stay in the cave of Thoor?

17-Abdullah: The Cave of Thoor where Prophet Muhammad together with Abu Bakr were hiding for 3days during Hijra. *Do you know what the first battle in Islam was?*

18- Ahmed: Badr

19-Abdullah: **excellent,** The Battle of Badr was a key battle in the early days of Islam. *Do you know what was the second battle in Islam?*

20- Ahmed: Uhud

21-Abdullah: **excellent,** The Battle of Uhud, in 625, Abu Sufyan ibn Harb, King of Mecca. Once again led a Meccan force against Medina. *What was the next battle after Uhud?*

22- Ahmed: Confederates

23-Abdullah: **excellent,** Battle of the Trench or (Battle of the Confederates) the battle that was Surrounding Medina in 627 , and the results Decisive Muslim victory , During these battles God helps Muslims by angels whose they fight with against non-Muslims. *What was the last battle during the prophet period?*

24- Ahmed: Conquest of Mecca

25-Abdullah: **excellent God bless you,** Mecca was conquered by Muslims on 11 December 629 AD

Dialogue 5

1-Abdullah: Welcome to Abdullah the tutor, please write your name

2-User: my name is Isra

3-Abdullah: Dear sister Isra welcome to the program, do you like to converse about the religion of Islam?

What is meant by Islam?

4-Isra: peace

5-Abdullah: excellent, Islam its Arabic word which literally means obedience and peace. (**Quran:** *Indeed, the religion in the sight of Allah is Islam. And those who were given the Scripture did not differ except after knowledge had come to them - out of jealous animosity between themselves. And whoever disbelieves in the verses of Allah, then indeed, Allah is swift in [taking] account.*). **Can you tell me one of the Islamic pillars?**

6-Isra: I Don't Know

7- Abdullah: Shahadah, profession of faith, is the first pillar of Islam. **What did the prophet Muhammad, wanted from the people?**

8-Isra: Monotheism

9- Abdullah: excellent, the prophet Muhammad (pace be upon him) want to deliver one message to all people that "There is no God but Allah". **Do you know what the second part of the Shahadah is?**

10-Isra: Muhammad is the Messenger of God

11-Abdullah: excellent God bless you, Muslims bear witness to the oneness of God by reciting the creed "There is no God but Allah and Muhammad is the Messenger of God.". **So does prophet Muhammad send to Arab people only?**

12-Isra: No

13-Abdullah: Good, Muhammad (peace be upon him) is the final Messenger of Allah to all humankind

(*Quran: Muhammad is not the father of [any] one of your men, but [he is] the Messenger of Allah and last of the prophets. And ever is Allah, of all things, Knowing.*). **Can you tell me the greatest obligations, we must do every day?**

14-Isra: Charity

15-Abdullah: I think the right answer is, Salah (prayer), is the second pillar of Islam. **Salah It's the only pillar that Muslim can do it in any conditions, who is that?**

16-Isra: I Don't Know

17-Abdullah: Salah (prayer) is the only pillar of Islam that person can do it in any conditions (i.e. **a person who cannot stand or sit down can pray while lying down by moving his head.**).**God has stressed the importance of prayer, do you know why?**

18-Isra: I Don't Know

19-Abdullah: prophet Muhammad said "The first thing one will be held accountable for on the Day of Judgment is prayer." **Do you how much prostration to God in a day during prayers?**

20-Isra: 5

21-Abdullah: I think the right answer is, the Number of Rakaahs that are performed in the 5 Daily prayers is 17. **Do you know what were the second pillars of Islam, and it's related to money?**

22- Isra: almsgiving

23- Abdullah: excellent, Zakat prescribes payment of fixed proportions of a Muslim's possessions for the welfare of the entire community and in particular for its neediest members.(*Quran: And establish prayer and give zakat, and whatever good you put forward for yourselves - you will find it with Allah. Indeed, Allah of what you do is Seeing.*). **To whom shall we give charity?**

24- Isra: for the needy people

25- Abdullah: excellent, the people entitled to Zakat are those places we can direct our Zakat to. God took charge of explaining for Himself what these places are, saying: (*Quran: Zakah expenditures are only for the poor and for the needy and for those employed to collect [zakat] and for bringing hearts together [for Islam] and for freeing captives [or slaves] and for those in debt and for the cause of Allah and for the [stranded] traveller - an obligation [imposed] by Allah. And Allah is Knowing and Wise.*). **Do you know The Duty that must be performed once every year, which is one months in the Islamic New Year?**

26- Isra: Ramadan

27- Abdullah: excellent, Ordained in the *Holy Qur'an*, the fast is an act of deep personal worship in which Muslims seek a richer perception of God.(*Quran: O you who have believed, decreed upon you is fasting as it was decreed upon those before you that you may become righteous.*). **When the month of Ramadan started?**

28- Isra: I don't know

29- Abdullah: *The sighting of the new moon marks the beginning of the Muslim lunar month that varies between 29 and 30 days. This month is recommended Suhoor* **Do you know why?**

Appendix 3: Pre and post test questions

To know you're Prophet Muhammad (Arabic version)

س 1 / ضع علامة (✓) أما العبارة الصحيحة وعلامة (✗) أمام العبارة الغير صحيحة:

- 1- انهزم المسلمون في غزوة أحد بسبب مخالفة الرماة أوامر الرسول محمد صلى الله عليه وسلم. ()
- 2- أمر الرسول صلى الله عليه وسلم المسلمون بالهجرة إلى الحبشة. ()
- 3- ولد الرسول محمد صلى الله عليه وسلم بالمدينة المنورة. ()
- 4- أنا أقتدي بالرسول عليه الصلاة والسلام في الصلاة فقط. ()
- 5- السيدة عائشة هي اول زوجات الرسول محمد صلى الله عليه وسلم. ()
- 6- هاجر النبي صلى الله عليه وسلم الى اليمن. ()
- 7- محمد صلى الله عليه وسلم هو رسول الله وخاتم النبيين. ()
- 8- الغار الذي كان يتعبد فيه الرسول صلى الله عليه وسلم هو غار ثور. ()
- 9- أرسل الرسول صلى الله عليه وسلم الى العرب فقط. ()
- 10- كانت مدة الدعوة الإسلامية سرّاً ثلاث سنوات. ()

س 2 / أختار الإجابة الصحيحة في كل مما يلي:

- 1- الذي وضع الحجر الأسود مكانه بعد تساقط الكعبة واعادة بنائها هو: (ابراهيم عليه السلام - اسماعيل عليه السلام - محمد صلى الله عليه وسلم)
- 2- ولد سيدنا محمد صلى الله عليه وسلم في عام (المجاعة - الفيل - الفتح)
- 3- لقب الرسول محمد صلى الله عليه وسلم بالصادق (الكريم - الحلیم - الأمين)
- 4- من الخلفاء الراشدون (سلمان الفارسي - خالد بن الوليد - أبو بكر الصديق)
- 5- رضي الله عنهم أجمعين .
- 6- اسم نبينا صلى الله عليه و سلم (عيسى - موسى - محمد)
- 7- توفي النبي صلى الله عليه و سلم في (مكة - الطائف - المدينة المنورة).
- 8- من يجب أن تحب أكثر من جميع الناس (أمك - نبيك - أبوك)
- 9- كان عمر النبي صلى الله عليه وسلم لما أرسله الله تعالى (أربعون سنة - خمسون سنة - ستون سنة) سنة
- 10- مرضعة الرسول محمد صلى الله عليه وسلم هي (امنة بنت وهب - خديجة بنت خويلد - حلیمة السعدية)
- 11- كنية الرسول عليه الصلاة والسلام (أبو القاسم - أبو حفص - أبو ابراهيم)

س 3 / أجب بكلمة واحدة فقط

- 1- أذن الله للنبي محمد (صلى الله عليه وسلم) بالهجرة الى المدينة النبوية , وقد صحبه في هجرته أفضل أصحابه. من هو هذا الصحابي ؟ -----
- 2- أول من أسلم من الصبيان هو -----

To know you're God (Arabic version)

س1 / ضع علامة (✓) أما العبارة الصحيحة وعلامة (✗) أمام العبارة الغير صحيحة:

- 1- كلمة التوحيد هي " لا إله إلا الله " ()
- 2- الشرك هو التقصير والتهاون في أداء الصلاة. ()
- 3- لا يعلم من في السموات والأرض الغيب إلا الله. ()
- 4- نستعيز بالله من الشيطان الرجيم قبل قراءة القرآن فقط. ()
- 5- معنى كلمة الرب هو المالك للشيء المتصرف فيه بما يريد. ()
- 6- الدين الذي يرضاه الله ويحبُّه هو الإسلام. ()
- 7- يسمى الانبياء والصالحون بالطواغيت. ()
- 8- ينفع الكفار ما يعملونه من الأعمال الصالحة من أطعام المساكين. ()
- 9- النفع والضرر كله بيد الله, ولا أحد ينفع ويضر إلا الله. ()
- 10- الانبياء كلهم على دين واحد هو الإسلام . ()

س2 / أختار الإجابة الصحيحة في كل مما يلي:

- 1- عاقب الله تعالى قوم نوح (الحرق – الصاعقة – الغرق)
- 2- يحاسب الإنسان يوم القيامة عن (جيرانه - نفسه - أهله)
- 3- ما أعظم الواجبات علينا ؟ (الصوم – التوحيد – الزكاة)
- 4- ما أعظم الذنوب ؟ (الكذب – النفاق – الشرك)
- 5- أنواع التوحيد هي (اثنان – ثلاثة – أربعة)
- 6- الطاغوت عبارة عن كل (من ترك الصيام – معبود من دون الله – من كذب)
- 7- من آيات الله في الكون , الجبال و: (العقل – الشراب – الشمس)
- 8- كان أكثر الناس قبل الاسلام يعبدون (القمر – الأصنام – الشجر)
- 9- خلقنا الله سبحانه وتعالى (للعمل – للصلاة – لعبادته)
- 10- قال رسول الله صلى الله عليه وسلم : من حلف بغير الله فقد (أشرك – ظل – فسق)

س3 / أجب بكلمة واحدة فقط

- 1- نزل القرآن الكريم في ليلة مباركة, هي ليلة -----
- 2- ----- بالله هو أن تعبد غير الله.

To know your religion (Arabic version)

س1 / ضع علامة (✓) أما العبارة الصحيحة وعلامة (✗) أمام العبارة الغير صحيحة:

- 1- الصدقة تنقص المال. ()
- 2- لا فرق في الأجر بين صلاة الجماعة وصلاة الفرد. ()
- 3- يجوز للمريض أن يترك الصلاة أثناء مرضه. ()
- 4- نزل القرآن الكريم في شهر شوال. ()
- 5- تعطى الزكاة للأغنياء. ()
- 6- من أركان العمرة الإحرام. ()
- 7- يرى المؤمنون ربهم إذا دخلوا الجنة. ()
- 8- الايمان بالكتب السماوية أحد اركان الايمان الستة. ()
- 9- الاحسان هو أن تعبد الله كأنك تراه فإن لم تكن تراه فإنه يراك. ()
- 10- أحب الأعمال إلى الله تعالى الحج. ()

س2 / أختار الإجابة الصحيحة في كل مما يلي:

- 1- يظهر القمر في أول الشهر (الميلادي - الهجري - اليوناني)
- 2- الحج هو الركن (الثالث - الرابع - الخامس) من اركان الاسلام
- 3- عدد سور القرآن الكريم (100 - 114 - 120)
- 4- عدد أركان الإسلام: (4 - 5 - 6)
- 5- متى تقول الحمد لله؟ (بعد الأكل والشرب - بعد العطاس- في كل حال).
- 6- ما أفضل يوم في العام (يوم الجمعة - يوم عرفة - يوم السبت)
- 7- عمود الاسلام (الصلاة - الزكاة - الحج)
- 8- أولي العزم من الرسل هم محمد صلى الله عليه وسلم و عيسى و موسى و إبراهيم و (لوط - هود - نوح) عليهم السلام أجمعين.
- 9- أحق الناس بالبر و الإحسان (الأم - الأب - الزوجة)
- 10- أعظم ايه في القرآن (اية الدين - اية الكرسي - اية الصيام)

س3 / أجب بكلمة واحدة فقط

- 1- وردت عدة سور في القرآن الكريم بأسماء بعض الأنبياء, أذكر سورة واحدة فقط -----
- 2- من الكتب السماوية, القرآن الكريم و -----

To know your prophet Muhammad (English version questions)

Q1: put the (✓) in front of the correct answers and (✗) in the front of the wrong answer:

1. Muslims were defeated in the Battle of Uhad because of the Shooters violation prophet Muhammad orders. ()
2. Prophet Muhammad ordered Muslims to immigrate to Abyssinia. ()
3. Prophet Muhammad Born in the AL Medina. ()
4. I followed the Prophet peace be upon him in the prayer only. ()
5. Aisha is the first wives of the Prophet Muhammad. ()
6. Prophet Muhammad migrated to Yemen. ()
7. Prophet Muhammad is the Messenger of Allah and the final Prophets. ()
8. The cave, which was the Prophet worship, is the cave of Thor. ()
9. Prophet Muhammad peace be upon him sends only to Arabs. ()
10. The Islamic secret call was for three years. ()

Q2: choose the correct answer from each of the following:

1. The Prophet in which he put the Black Stone in his place after the Kaaba falling and rebuilt is (Ibrahim - Ismail - Muhammad).
2. Prophet Muhammad born in the year of the (Famine - the elephant - Conquest)
3. The people before Islam knows Prophet Muhammad's as (Al Saadiq (Alameen - AlHalim - Alraheem)
4. It is a famous Caliph (Salman the Persian - Khalid ibn AlWalid - Abu Bakr) God bless them all.
5. The name of the Prophet peace be upon him (Jesus - Moses - Mohammed)
6. Prophet died in (Mecca - Taif - Medina).
7. Who should we love more than all the people? (Your mother - Prophet - your father)
8. The age of the Prophet, when Allah tell him to deliver the message of Islam was (Forty years - fifty years - sixty years) years
9. The Prophet was entrusted to (Halima Sadia - Khadija Binkhuwailed – Amina Bintwahab).
10. The nickname of the Prophet peace be upon him was (Abu Alqasim - Abu hafs - Abuibrahim)

Q 3: / answer by typing a verse from Quran or a relevant word

1. The first verse was revealed to the Prophet Muhammad (peace be upon him), is the verse -----
2. A river in heaven given to our Prophet Muhammad (peace be upon him), as the almighty Allah said -----

To know your God "Allah" (English version questions)

Q1: put the (✓) in front of the correct answers and (✗) in the front of the wrong answer:

1. Monotheism word defined, as "there are no God but Allah". ()
2. Shirk is negligence and laxity in the performance of prayer. ()
3. Do not know of the heavens and the earth, the unseen except Allah. ()
4. seek refuge from Allah from the accursed Satan just Before reading the Quran. ()
5. Meaning of the word of the Lord is the owner of everything, including the assigned wants. ()
6. religion that pleases God and he loves is Islam. ()
7. The so-called prophets and righteous called Taiwaghit. ()
8. Kafar benefit from what they do good works to feed the needy. The benefit and harm are all in God's hands, ()
9. not a benefit and harm, but, God willing. ()
10. The prophets, are all on one religion which is Islam. ()

Q2: choose the correct answer from each of the following:

1. God punished the people of Noah by (Burn - Thunderbolt - drowning)
2. Human will judged on the Day of Judgment on (Neighbors - himself - his family)
3. What is the greatest duties on Muslim? (Fasting - Unification - Zakat)
4. What is the greatest sins? (Lying - hypocrisy - polytheism)
5. Types of monotheism are (two - three - four)
6. Tawaghet is all (of fasting - Idol without God - of a lie)
7. one of the Allah sign in the universe is, (the mountains- drink - Sun)
8. more people before Islam worship (Moon - idols - trees)
9. Allah created man (to work - to pray - to worship Him)
10. The Messenger of Allah, peace be upon him: said to ask Any one apart from Allah is (Phasq - Shark - lost)

Q 3: / answer by typing a verse from Quran or a relevant word

1. Quran down on a blessed night, which is the night of -----
2. ----- God is that to worship another God.

To know your religion "Islam" (English version questions)

Q1: put the (✓) in front of the correct answers and (✗) in the front of the wrong answer:

1. Charity decreases money. ()
2. There is no difference in rewards between the congregational prayer and the prayer of the individual. ()
3. The patient may leave the prayer during his illness. ()
4. Quran revealed to Prophet Muhammad in the month of Shawwal. ()
5. Zakat is given to the rich people. ()
6. Ihram is one of the Islamic pillars. ()
7. Believers see their Lord when they enter Paradise. ()
8. Believe in the holy books, is one of the six pillars of faith. ()
9. Ihsan is to worship Allah as though you see Him, and though you do not see Him, you know that He sees you.. ()
10. One of the most actions that Allah love is the pilgrimage. ()

Q2: choose the correct answer from each of the following:

1. Moon appears in the first calendar month of the (Gregorian - Hijree - Greek)
2. Hajj is the pillar number (III - IV - V).
3. Number of chapters in the holly Quran are (100-114 -. 120)
4. Number of the pillars in Islamic religion are: (4-5 - 6)
5. When you say thankfully?
(After eating and drinking - after eating only - in each case).
6. What is the best day in the whole year?
(Friday - the day of Arafat - Saturday)
7. Islam column is (prayer - Zakat - Hajj)
8. There were five prophets who had divine books and independent teachings, they are prophet Muhammad, Moses, Ibrahim, Isa, and (Lot - Hood - Noah) peace wholes them.
9. Deserving people in righteousness and benevolence is (mother - father - wife)
10. The greatest verse in the Quran (the verse of Aldean – the verse of chair – the verse of fasting)

Q 3: / answer by typing a verse from Quran or a relevant word

1. Many chapters in Quran, have the name of the prophet can you name one of them -----
2. From the holly books are the Quran and -----

Appendix 4: Questioner (Arabic version)

Questioner distributed in Abdullah CITS (Adult's Evaluation)

التقييم	يرجى تقييم هذه الأسئلة
قليل 1 - 2 - 3 - 4 - 5 عالي	1. التعليمات
قليل 1 - 2 - 3 - 4 - 5 عالي	2. واجهة تطبيق البرنامج
قليل 1 - 2 - 3 - 4 - 5 عالي	3. مستوى التعليم
قليل 1 - 2 - 3 - 4 - 5 عالي	4. كيف كان فهم عبدالله المعلم لك
قليل 1 - 2 - 3 - 4 - 5 عالي	5. هل وجدت البرنامج المعلم مفيدا لك؟
قليل 1 - 2 - 3 - 4 - 5 عالي	6. هل كانت المحادثة طبيعية؟
قليل 1 - 2 - 3 - 4 - 5 عالي	7. هل كانت المحادثة محببة؟
قليل 1 - 2 - 3 - 4 - 5 عالي	8. هل تشعر بأن عبدالله المعلم ساعدك في المراجعة؟
نعم / لا نعم / لا نعم / لا نعم / لا	9. هل ترغب باستخدام مصادر مثل عبدالله المعلم : • بدلا من التعلم وجها لوجه مع المدرس ؟ بدلا من التعلم من الكتاب؟ بالإضافة إلى الدروس الصفية؟ هل تريد استخدام المصادر على الإطلاق؟
	10. ماذا يمكن أن يفعل عبد الله المعلم لمساعدتك على التعلم؟
	11. يرجى ذكر نقطتان إيجابيتان حول استخدام عبدالله المعلم
	12. يرجى ذكر نقطتان سلبيتان حول استخدام عبدالله المعلم

Questioner distributed in Abdullah ATA-CITS (Children's Evaluation)

			1- من الممتع استخدام برنامج عبد الله المعلم
			2- هنالك الكثير من المواضيع الجديدة كي تعلمها
			3- من السهل تذكر الاجابة الصحيحة
			4- عبد الله المعلم هو برنامج سهل الاستخدام
			5- عبد الله المعلم يوفر لي المعلومات بطريقة مفهومة
			6- من السهل استرجاع معلوماتي عند استخدام عبد الله المعلم
			7- عبد الله المعلم اعطاني معلومات كثيرة وزائدة عن طاقتي
			8- هل ترغب بأستخدام عبد الله المعلم مرة ثانية

Appendix 5: Ethics Forms

INFORMATION SHEET FOR PARENTS/CARERS

INFORMATION SHEET FOR PARENTS/CARERS

Researcher: Mr Omar Alobaidi
(Supervisor: Dr. Keeley A Crockett)

Address: Room: E113
School of Computing, Maths and Digital Technology
Manchester Metropolitan University
Chester Street
Manchester, M1 5GD
Phone: +(44) 0161 247 47857
Email: oalobaidi@yahoo.com

Your child is being invited to take part in a research study. In order for you to decide whether your child would like to take part, this information sheet explains why the research is being undertaken and what it will involve. Please email Omar Alobaidi at the address above if there is anything that is not clear or if you would like more information.

What is the purpose of the research?

The purpose of this research study is to evaluate a new technology for a computer based tutoring system called Abdullah. The new tutoring system can analyse each learner's actions through conversation during tutoring scenarios to estimate their knowledge and skills. The system incorporate graphics, questions/answering and conversation to teach the three fundamental and principals that every Muslim must learn which is to know Your God (Allah), his messenger and the religion of Islam.

Why is the study being done?

The study is being undertaken to evaluate the new tutoring system to see if the system can deliver material in a similar way to a classroom teacher and therefore offer additional support to the students if required.

Why are being asked to allow your child to take part?

As part of this research we are looking for children between the ages of 10 to 12 years to take part in the study. Your child has been chosen to take part because they are within this age bracket. The tutoring material has been selected to be appropriate to this age group and been approved by Mrs Najah Rabah the head teacher (Almanar School). The study takes into consideration the ability of children at the age of 10 years old in terms of their skills in the Arabic language, the ability to writer longer Arabic sentences, writing very basic short stories or dialogues, and using grammatical progression such as 'awalan, thoma, akheeran', etc.

Does my child have to take part?

No. This is an entirely voluntary study. If you choose not to participate, it will not affect you or your child in any way. If you give your consent for your child to participate, you will be asked to sign a consent form (attached). Even if you give consent, you will still be free to withdraw your child at any time and without giving a reason.

Are there any disadvantages or risks in allowing the children to take part?

No, however Mrs Najah Rabah the Head Teacher of the school (Almanar School) supports this study and has given permission for it to be conducted at Almanar private School.

What will happen to their children if the parent/guardian agrees to them taking part?

Your child will be in a familiar classroom setting with both class teacher (Mrs Isra Aldouri) and Omar Alobaidi (the researcher) present.

Omar Alobaidi (the researcher) will first introduce the tutoring system to the children. Access is via the WWW.

Your child will be asked first to login to the Abdullah tutoring system using a nickname provided by Omar. This prevents personal data from being captured.

Your child will then use the system by having a conversation based tutorial with Abdullah the Tutor on one of three random topics (know Your God (Allah), his messenger and the religion of Islam). At the start of the tutorial, Abdullah will ask your child some questions about their current knowledge about the random topic.

Your child will then start a conversation, discussion and interpretation in classical Arabic of one of three random topics and the tutorial will take no longer than 45 minutes.

On completion of the conversational tutorial all students will be asked to complete two anonymous questionnaires: one on how they liked using Abdullah and the other will be the same questions they were asked about the topic before starting the tutorial. The class teacher (Mrs Isra Aldouri) will present all the time.

Anonymous data about the conversational tutorial will be stored on a secure server at MMU in the form of log files. There will be no way to identify or associate a specific child with a specific tutorial.

Who will have access to the data?

Mr Omar Alobaidi (the researcher) and class teacher (Mrs Isra Aldouri)

Who is funding the research? Mr Omar Alobaidi (the researcher)

Who they should contact for further information? Omar Alobaidi (the researcher) at the contact address at the top of this participation sheet

How will data be anonymised?

The information gathered from the pupil is stored securely, coded anonymously (each pupil can choose a nick name), and presented in aggregate form, so that the identity of any individual or home cannot be disclosed outside the research site. The procedures for handling, processing, storage and destruction of data gathered in this study are compliant with the Data Protection Act 2008 and the Q.U.B. Data Protection Policy.

Who many participants?

The number of participants will be the same number of the pupils in a class, so year 4 (24 students), year 5 (20 students), and year 6 (18 students).

Where will the research sessions take place?

The session will take place at your child's school. Every effort will be made to ensure that the research sessions are as enjoyable and relaxed as possible for the children. The total testing Time will not exceed 60 minutes.

Letter to parents

Dear Parent /

My name is Omar Alobaidi and I am currently a PhD student in the School of Computing, Maths and Digital Technology at Manchester Metropolitan University. The main part of my research is to develop Arabic conversational intelligent tutoring system (CITS) to support teaching and learning of the Quran to children aged (10-12). The conversational agent will allow the pupils to converse in modern standard Arabic to explore a number of topics and the system will retrieve Quran verses and other information like the meaning of those verses in the Tafsir (Quran Translation). The system will allow the pupils to ask questions and discuss topics in the form of an online tutorial.

During the evaluation process, I would like if possible for pupils within the school to engage with the Arabic conversational intelligent tutoring system in a tutor led session on a number of topics. During the tutorial, students will need to access the system via the internet. I will be present to give an overview of the task to both the tutor and the pupils.

Please send the signed agreement form to school with your student as soon as you have completed it. Student will not be able to use the System or engage in the evaluation process until the agreement form is signed by you and returned to the class teacher.

Child's Name _____ Class: _____

Parent's Name (please print): _____

Parent's Signature _____ Date: _____

Many thanks for your cooperation,

Researcher: Mr Omar Alobaidi
Address: Room: E113
School of Computing, Maths and Digital Technology
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Parent's consent form

CONSENT FORM FOR PARENTS/CARERS

Arabic Conversation Agent for Modern Islamic Education

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(Supervisor: Dr. Keeley A Crockett)

I give my consent for my child _____ (child's name)

To take part in the above named research project.

I understand that all data will be kept confidential and that I have the right to withdraw my child from the study at any time.

Print name _____

Signed _____

Date _____

Appendix 6: Author Publications

Omar G. Alobaidi, Keeley A. Crockett SMIEEE, Jim D. O'Shea MIEEE, and Tariq M. Jarad. Abdullah: An Intelligent Conversational Tutoring System for teaching Islamic topics in both modern and classical Arabic language. Manchester Metropolitan University Research Day (25th of April 2013).

Omar G. Alobaidi, Keeley A. Crockett SMIEEE, Jim D. O'Shea MIEEE, and Tariq M. Jarad. Abdullah: An Intelligent Arabic Conversational Tutoring System for Modern Islamic Education. International Conference of Computational Intelligence and Intelligent Systems, London, July 2013. ISSN: 2078-0958

Omar G. Alobaidi, Keeley A. Crockett SMIEEE, Jim D. O'Shea MIEEE, and Tariq M. Jarad. The Application of Learning Theories into Abdullah: An Intelligent Arabic Conversational Agent Tutor. ICAART 2015 - International Conference on Agents and Artificial Intelligence, Lisbon-Portugal, January 2015.

Abdullah: An Intelligent Conversational tutoring system for teaching Islamic topics in both modern and classical Arabic language

Omar G. Alobaidi, Keeley A. Crockett, Jim D. O'Shea, Tariq M. Jarad, and Senior Member of IEEE
Manchester Metropolitan University, United Kingdom
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Abstract— This paper focuses on the development of a novel Arabic Conversational intelligent tutoring system (CITS) called Abdullah the tutor, Abdullah CITS is a software program that teach students aged 10 to 12 years old the essential topics in Islam with all supportive evidence from Quran and Hadith, allowing conversation, discussion and interpretation with verses in classical Arabic language by engaging in dialogue using Modern Arabic language (MA).

Keywords: intelligent tutoring system; Conversational agents; conversational intelligent tutoring systems; Pattern matching; User interface;

INTRODUCTION

Arabic language it's an official language of more than twenty countries, and a major spoken Language by over 300 million people worldwide [1]. tow forms of Arabic language that's Modern Standard Arabic (MSA) which is the official language throughout the Arab world, it is used in everyday language, in the media, education, and literature, MSA mainly derived from the Classical Arabic language (CAL), CAL known as Classical Arabic or Quranic Arabic which is the standard form of the language used in the holy Quran the religious text for Muslims. However Abdullah the Tutor aims to deliver the main principles that every Muslim must know which is to know your God, His messenger and the religious of Islam with all the supportive evidence from Quran and Hadith [2].

A conversational Agent (CA) is a software program intended to converse with a human in ordinary natural language [3]. CAs have been used effectively in many applications, such as database interfaces [4], student's debt management guidance [5], computerized learning [6] and conversational intelligent tutoring systems (CITS).

Developing a CITS for the Arabic language faces many challenges due to complexity of the morphological system, non-standardization of the written text, ambiguity, and lack of resources. However the main challenge for the developed Arabic CITS is how the user utterances are recognized and responded to by the CA, as well as how the domain is scripted and maintained. A number of approaches have been implemented to tackle these issues such as the use of natural language processing [7], the incorporation of short text semantic sentence similarity measures (STSM) [8] and pattern matching (PM) [9].

The proposed framework for developing Abdullah CITS is based on a Pattern Matching (PM) CA' to handle users' conversations as it can give the impression of some kind of intelligence [10], and it is not require the input to be a grammatically correct or a complete input, as it match the utterance with a set of scripted patterns in a specific domain. The PM approach is considered to be an ideal solution for developing an Arabic CA because it's firstly not based on any grammatical or linguistic details and thus it will deal

usefully with the complexities of the Arabic language. Secondly it is inexpensive computationally and does not require intensive processing to understand a user's utterance as it is based on matching process.

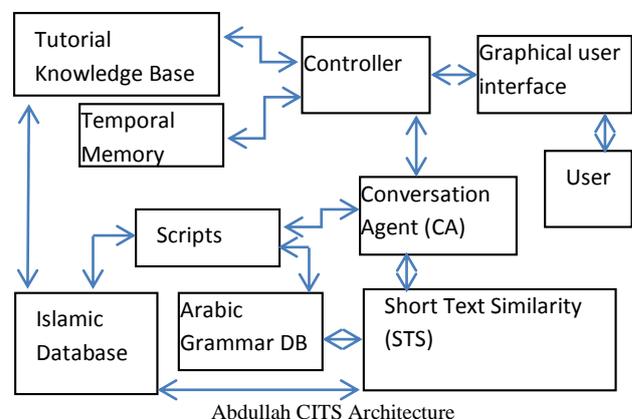
The aim of the designed system is to evaluate the ability of Arabic CITS to adapt and handle both modern and classical Arabic language in the context of a learning environment. Abdullah CITS also offers intelligent solution and problem support for learners, buy measuring the student's knowledge during the tutoring; Abdullah can personalize the delivery of material for each individual learner to improve the effectiveness of the tutoring.

The CITS was initially evaluated by participants using a domain of Islamic religious, that is, adults with various levels of expertise, which indicated promising results.

This paper is organized as follows: Section II will introduce Abdullah CITS, Section III describes the experimental methodology, and Section IV will conclude and highlight areas for further work.

ABDULLAH CITS

Abdullah the tutor CITS was designed to model a human tutor by directing a tutoring conversation. The proposed framework for Abdullah CITS consists of three main components as shown in figure 1 ,which include the knowledge base (Islamic DB, Arabic Grammar DB, and the Scripts), Conversation agent, and the Intelligent tutoring system (Tutorial knowledge base, Controller, and Temporal memory).



Abdullah depends on the tutorial knowledge base and the conversation scripts to deliver the tutorial conversation to the learners. To improve the learning process and to deliver the best materials to students during the tutoring session Abdullah was contains novel features like images and sound effects, along with the recording of the behavior and the knowledge of the students during the learning session. Figure 2 shows Abdullah the Tutor CITS graphical user interface (GUI) leading the student through a

set of questions aimed to teach learners by asking questions about the topic and measuring the student's knowledge and behaviour during the session. During the tutoring conversation session the learner has been asked during the pilot study a previous question about the main topic (Knowing your God), and Abdullah has responded to confirm that the learner's previous answer was correct, also the CITS was providing the full answer to the question along with the appropriate verse from Quran and has stated the next step in the tutorial by asking the linking question to the next content of the tutorial session.



1. Abdullah the Tutor Answer
2. An answer to a previous question (Sign of god are a lot, moon and sun are an examples of god's signs)
3. And of His signs are the night and day and the sun and moon. Do not prostrate to the sun or to the moon, but prostrate to Allah, who created them, if it should be Him that you worship.
4. God create human, can you give another example

A screen shot from Abdullah CITS Tutoring session

EXPERIMENTAL METHODOLOGY

This section will review the selected domain of teaching Islam, as well as the description of the experiments that's been used to evaluate Abdullah CITS framework.

The selected domain is concerned with teaching the students at the primary school the three principals that every Muslim must learn which is to know Your God (Allah), his messenger (prophet Muhammed), and the religion of Islam, with the supportive evidences (Quran and Hadith). The script consists of contexts based on the main topics in Islamic religious such as the pillars of Islam (Faith or belief in the Oneness of God, Establishment of the daily prayers, etc.) as well as the contexts that's dealing with the user natural Arabic language. Abdullah CITS is therefore designed to deliver the Islamic topics to learners in classical Arabic language while the learners converse in modern Arabic language.

Two sets of experiments were undertaken to measure the participants learning over the session. The first experiment where based on log file to record the dialogue, timings, knowledge and other behavioural factors were analysed to assess each learner's performance during the tutoring session. Twelve participants were asked to revise their knowledge of Islamic topics by completing the online Abdullah CITS revision tutorial. The scenario is described as follows: The user will engage in a tutorial conversation with one of the three Islamic topics by answering a tutorial question that's cover different contents in the selected topic, the learner will move from one content to another in a goal oriented structure. The user is able to ask questions relevant to the domain during the tutoring conversation and seek clarification. While the second experiment will based on the user feedback from the initial pilot study showed that Abdullah was well received, understandable and helpful 85% of the user would use a CITS like Abdullah to support classroom tutoring, 20% stating they use Abdullah instead

of face to face teacher only 30% of learners agreed that they would use the Abdullah the tutor instead of reading a book.

CONCLUSIONS AND FURTHER WORK

This paper has presented the novel architecture and methodology for developing Abdullah the Tutor CITS, the developed tutor aims to teach students the basic principles of Islam allowing the conversation in both modern and classical Arabic language. An Arabic CA was used in Abdullah CITS, and a number of novel features were added to the Arabic CA to improve the agent understanding to users utterances, however pattern matching technique implemented in the Arabic CA because it's been consider to be an ideal solution for a conversation agent based on Arabic language, because it solves the complexities of understanding the Arabic language, by simply matching the utterance with a set of scripted patterns. Abdullah was proposed to deliver a personalised natural language tutorial conversation and to give an intelligent solution analysis and problem solving support. Further work will entail an evaluation with students in primary school using scenarios with more depth and challenges.

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Abdullah: An Intelligent Arabic Conversational Tutoring System for Modern Islamic Education

Omar G. Alobaidi¹, Keeley A. Crockett¹ SMIEEE, Jim D. O'Shea¹ MIEEE, and Tariq M. Jarad¹

Abstract— This paper focuses on the development of a novel Arabic Conversational Intelligent Tutoring System (CITS) called Abdullah the tutor, Abdullah CITS is an online system that teaches students aged 10 to 12 years old the essential topics in Islam utilizing supportive evidence from the Quran and Hadith, allowing conversation, discussion and interpretation with verses in classical Arabic language by engaging in dialogue using Modern Arabic language. The proposed framework for developing Abdullah CITS is based on a Pattern Matching approach to handle the user's conversations, and to solve the complexity and ambiguity of processing the Arabic language. This paper describes the architecture of Abdullah and introduces the novel scripting language that has also been developed. The results of a pilot study are reported where the evaluation has indicated promising results.

Index Terms— Conversational agents, intelligent tutoring system, knowledge base, pattern matching.

INTRODUCTION

The Arabic language is an official language of more than twenty countries, and a major spoken language by over 300 million people worldwide [1]. Two forms of Arabic language that are typically used in daily conversations between people are: Modern Standard Arabic (MSA), which is the official language throughout the Arab world, as it is used in everyday language, in the media, education, and literature. MSA is mainly derived from the Classical Arabic language (CAL). CAL known as Classical Arabic or Quranic Arabic is the standard form of the language used in the holy Quran, the religious text for Muslims. The ability to develop an intelligent tutoring system able to converse in MSA and CAL poses a significant challenge. The Arabic language is considered as being a complex language which is often ambiguous in nature. There is also a lack of computational natural language resources especially for CAL.

AutoTutor [2] and Oscar [3] are recent examples of CITS, which are designed to help students learn about a domain using a CA. However both of these CITS's are designed only to converse in English and use language specific supported language. AutoTutor does not incorporate or consider the various different learning styles during a tutoring session, which effectively means each student is provided with the same learning experience regardless the ability. Oscar CITS incorporates the Index of Learning Styles (ILS) to facilitate personalized learning but has been designed only for the English language. In this paper, a novel architecture for an Arabic CITS, known as Abdullah is presented. Abdullah is a CITS which delivers of the main principles that every Muslim must know which is to know your God, His messenger and the religious of Islam with

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Intelligent tutoring systems (ITS) are adaptive educational systems that employ intelligent technologies to provide individualised instruction. The main goal of ITS is to provide the benefits of one to one instruction automatically, and cost effectively [5]. ITS enables participants to practice their skills and to build a model of the preferences and knowledge of the student by carrying out the tasks within highly interactive learning environments [6]. A conversational agent (CA) is a software program intended to converse with a human in ordinary natural language [7].

Two forms of Conversational Agents have been developed: namely, Linguistic Conversational Agents and Embodied Conversational Agents [8]. Embodied CAs possess attributes such as an animated humanoid body and facial expressions, including movement of mouth and eye gaze [9], while Linguistic CA's handle conversation in written or spoken forms [10]. CAs has been used effectively in many applications, such as database interfaces [11], student's debt management guidance [12], computerised learning [13] and conversational intelligent tutoring systems. This paper describes Abdullah the Tutor, a web based CITS with a CA interface which leads the tutoring session, asking questions, moving from topic to topic in a session and offering intelligent feedback to students. Abdullah CITS also incorporates a variety of learning support to students such as the use of illustrations, and sound effects in order to stimulate the learning environment. A novel generic architecture has been designed which will facilitate the development of future Arabic CITS for application in other domains. In addition, a new Arabic scripting language has been created to be able to analyse and interpret both MSA and CAL. This paper is organised as follows: Section II will describe the design of the Tutoring Knowledge Base, Section III describes current CA developments and the challenges faced by the Arabic language, Section IV introduces the Abdullah CITS, Section V describes the Pilot Study, Section VI will discuss the results and VII will conclude and highlight areas for further work.

DESIGNING AND BUILDING THE KNOWLEDGE BASE

The knowledge base of Abdullah CITS consists of four main components that are the Islamic Database (IDB), the Arabic Grammar Database (AGDB), CA Scripts (CAS), and the Tutorial Database (TDB). These Databases work together in a novel way, and it's considered being the brain of Abdullah the Tutor CITS. These components were organized into two main partitions, the first one which considers the primary parts of the knowledge base consists of the (IDB, AGDB, and CAS). The CA uses scripts to guide the user through predefined topic paths for a particular domain. The script contains a number of contexts which are organized according to the domain's topics. Each context contains rules that have a pattern to represent the user input and an appropriate response from the specific domain [14]. Figure 1

shows a small example of one rule that has been produced using the new Arabic CA Scripting language.

Context #1 Context Name : Facts About Quran
RuleNumber: 1
RuleName: how many
Pattern: How many times the word * repeated in Quran
Response : the word # is not in Quran
RunSQL: select count(word) form QuranTable;

Figure 1. Scripting Language

Figure 1, illustrates one of the features of the new Arabic CA Scripting Language. The CA has the ability to retrieve dynamic information by calling (RunSQL) when the user type an utterance like “How many times the word Muhammad repeated in Quran” this will match with the pattern in rule #1. The CA will then extract the word (Muhammed) from the user utterance and then use the word in (RunSQL) to get the response from the Quran table in IDB. And if the RunSQL statement returns a null value this mean word is not in the Quran and the CA will display the default response which is (the word ‘User Word’ is not in the Quran). The IDB is the most important part in Abdullah CITS brain, as it is the source of the tutoring material during the session. The Islamic Database has been derived from two main sources that are being the Quran and Hadith (the statements of prophet Muhammed) [15]. The Quran is originally written in classical Arabic language, and is organized into 114 chapters (surah) of various lengths with specific number of verses (ayat) in each chapter. While the Hadith is organized according to Sahih Al-Bukhari [16]. Al-Bukhari groups Hadiths to a number of chapters each one covers the almost aspects of Muslim life (so there is for example a chapter about prayers, charity, and so on) [17] [18]. The Arabic Grammar Database is an essential part for Abdullah CITS as it contain the classification of the Arabic sentences (Questions and Statements sentences), and information related to the specific language grammar such as whether the given sentence is a question or an exclamatory sentence. The tutorial knowledge base is the second partition of Abdullah CITS knowledge base and it’s responsible for managing subject information between learners.

III. CONVERSATIONAL AGENT AND THE CHALLENGES FACED BY ARABIC LANGUAGE

Conversational agents (CA) allow people to interact with computer systems using natural language dialogue. Existing CA’s can be categorized according to the development process into three main approaches: These approaches are Natural Language Processing (NLP) [19]; short text semantic sentence similarity measures (STSS) [20]; and Pattern Matching (PM) [21]. CA based on NLP refers to the process of constructing machine understandable meaning representations from natural language input. Arabic CAs potentially has a number of limitations. First, user utterances are expected to be grammatically correct, which is often not the case. Second, natural language used by humans is extremely rich in form and structure, and very ambiguous. A word might have more than one meaning (lexical ambiguity) or a sentence might have more than one structure (syntactic ambiguity), and for these reasons, the NLP approach is not appropriate to build a CA based on the Arabic language

[22]. The second approach for developing CA is the use of a STSS to measure the similarity between short texts of sentence length (10 -25 words long) [23]. The STSS measure focuses directly on computing the similarity between short texts of sentence length through the use of knowledge base such as the English WordNet [24]. Using a STSS measure within a CA is more effective as it reduces the scripting effort to a minimum by replacing the scripted patterns by a few natural language sentences in each rule [25]. However the lack of resources, such as an appropriate Arabic Wordnet (AWN) for classical Arabic language (AWN is only available for Modern Arabic language [26]), as well as the ambiguity of Arabic language (such as Morphological and Syntactic ambiguity), led the researchers to the traditional approach for building a CA using Pattern Matching techniques.

Pattern Matching (PM) is the process of matching a string or a sequence of strings within an utterance in a pattern-based rather than attempting to understand the user input. PM utilizes wildcards to match a portion of the user’s utterance to patterns within each rule. As PM techniques focus on matching key words within an utterance, they do not require the utterance to be grammatically correct or the input to be a complete. Therefore the PM approach is considered to be an ideal solution for an Arabic based CA as it solves the complexities of understanding the Arabic language, by matching the utterance with a set of scripted patterns [27].

IV. ABDULLAH CITS

Abdullah CITS is a novel conversational intelligent tutoring system which can ask questions and offering problem-solving support rather than simply presenting the answers. Abdullah was designed to model a human tutor by directing a tutoring conversation. Abdullah employs an Arabic Goal Oriented CA (AGO-CA) and a novel scripting language to intelligently lead an online tutorial, and to teach the Quran allowing conversation and discussion in both classical and modern Arabic language. The AGO-CA aims to steer the conversation towards the goal fulfilment by carefully written the CA’s responses, and by managing the unexpected utterances in a way that appears intelligent. Abdullah works as a personal tutor that is available at any time and place, and which provides instant answers to questions, feedback, and support through natural language conversation with the user. Abdullah depends on the tutorial knowledge base and the CA scripts to deliver the tutorial conversation to the learners. To improve the learning process and to deliver the best materials to learners during the tutoring session Abdullah has a number of distinct Arabic CITS features such as:

- Using images and sound effects to capture student’s attention during the session.
- Recording the learner’s behaviour and knowledge in order to direct the session according to the learners level (discussed in more detail in section VII).

Figure 2 shows a screenshot of Abdullah the Tutor CITS graphical user interface (GUI) which leads the student through a set of questions aimed to teach learners about the topic. During the tutoring session, the student has been asked a previous question about the main topic (Knowing your God), and Abdullah has responded to confirm that the learner’s previous answer was correct. Abdullah also

provided the full answer to the question along with the appropriate verse from the Quran and has stated the next step in the tutorial by asking the linking question to the next part of the tutorial session.



1. Abdullah the Tutor Answer
2. An answer to a previous question (Sign of god are a lot, moon and sun are an examples of god's signs)
3. And of His signs are the night and day and the sun and moon. Do not prostrate to the sun or to the moon, but prostrate to Allah, who created them, if it should be Him that you worship.
4. God create human, can you give another example

Figure 2. A screen shot from Abdullah CITS Tutoring session

The proposed framework for Abdullah CITS consists of three main components as shown in figure 3.

The ITS (to personalise teaching according to individual student's characteristics such as the knowledge of the subject, and the behaviour), the knowledge base (to provide the sources/material of the learning topics), and the CA (to lead the tutorial through a natural language dialog).

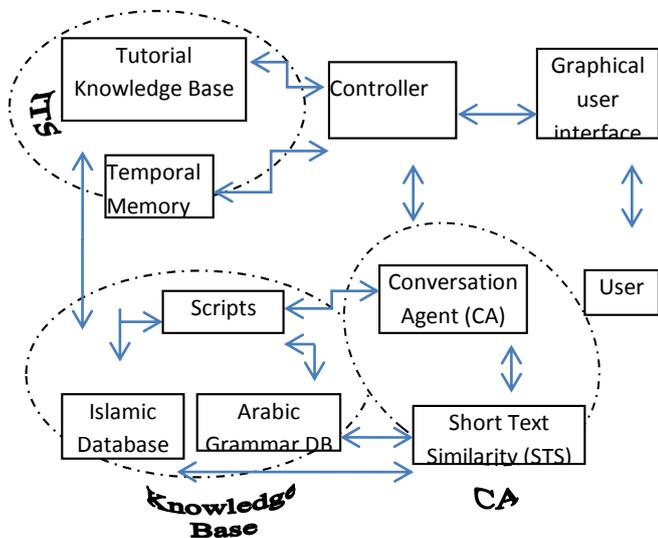


Figure 3. Abdullah CITS Architecture

The controller communicates with all components to manage the conversation between the user and the Arabic CA, as well as to provide the suitable material content to suit different students' knowledge by interacting with the Tutorial knowledge base and temporal memory (TM). The TM is used to record a number of variables such as answers, questions, and user statements during the conversation which are stored in a Log File (described in section V).

The controller will build a model of the students' knowledge and uses that model for teaching students and to provide intelligent assistance. The controller also provides an utterance checking process. Before proceeding to match against the patterns within the rules, the controller will check whether the utterance is empty, repeated, or unsuitable for the tutoring purpose. The Arabic CA will receive natural Arabic language text (modern and classical Arabic) and information about the tutoring topic from the graphical user interface (GUI), tutoring knowledge base via the controller.

The Arabic CA accesses the scripts database to find the best match to generate the response back to user.

Storytelling is one of the most powerful and simplest methods for learning. The use of stories in education has been found to be most useful in language learning, such as religious subjects, and for encouraging students to share personal experiences [28][29]. Interactive digital storytelling is a valid educational tool to teach multimedia, literacy and narrative skills and has been shown to excite people about learning [30]. Stories must also be learner designed, in that they need to be tailored for the specific audience they are delivered too [31]. In most religious texts, such as the Quran, storytelling is the natural way in which information about fundamental beliefs is taught.

Abdullah CITS was designed according to a number of theories (Gagne theories for learning [32]). Applying Gagne's theories is an excellent way to ensure an effective and systematic learning program as it gives structure to the lesson plans and a wider view to the teaching [33]. Gagne presented five learning outcomes which are Verbal Information (Describing the basic description of knowledge and facts "Allah is the Creator of all things, and He is, over all things, Disposer of affairs" Quran), Intellectual Skills, Cognitive Strategies, Motor Skills, and Attitudes (mental states that influence the choices of personal actions "i.e. An utterance describing that the user don't like Angels", then Abdullah CITS will give an appropriate response along with a verse from the Quran). These learning outcomes are extremely useful for analyzing learning in a school context [34]. Gagne learning theories are now briefly described along with a description of how they are applied in Abdullah.

1. Gaining learner's attention, Capturing student's attention is the first and most important issue for learning. Two techniques have been used to deal with this event, in the design of Abdullah. A graphical user interface (GUI) that begins with an animated title screen accompanied by sound effects, to increase children's visual orientation. In addition each lesson will start with thought-provoking question or interesting fact about the selected topic to be learned.

2. Informing learners of the objective. To help the learners complete the lesson and to get the maximum benefit of the topic, the learning objective must be listed early in each lesson. An initial image is displayed at the beginning of the lesson describing that on completion of the lesson, the learner will have a brief understanding of the topic, along with supportive evidence from the Quran and the Hadith.

3. Stimulating recall of prior learning. The recall will be stimulated by asking questions about how well the learners understand previous concepts or the body of contents in general. However all the tutorial questions are organized in the Tutorial Knowledge Base as questions with answers in a default style (A normal basic question which designed to suit different level of student's knowledge), or as questions with answers in basic detailed style (A type of questions for the student's with low level of knowledge). Student's knowledge will be measured during the tutorial by a number of variables, such as the percentage of the correct answers, whether or not the students ask a question related to the main topic, and have the students provided any information

using CAL (i.e. a verse from Quran or Hadith). During a tutorial, Abdullah CITS will direct the learner either into the default or detailed Question Answer style.

4. Presenting the content. The way that the course content is presented to students will reflect the teaching style of the instructor. Abdullah's intelligent approach includes presenting contents in the sequence and style most suited to the individual's knowledge. However the contents of Abdullah CITS was organized according to the book of monotheism of the primary school year (3, 4 and 5) [35], that's been printed and organized by the Ministry of Education and Deputy Ministry for school in Saudi Arabia.

5. Providing feedback. As learners practice new topics it is very important to provide a specific and immediate feedback on the learner's performance. Abdullah will display an appropriate encouragement after each correct answer, partially correct, and Low near miss Answers. As an example a match of 80% between utterance and pattern script is classified as correct answer and Abdullah will respond with a message like "excellent God bless you". A match of 50% is classified as partially correct answer and Abdullah will respond with a message like "Excellent". A match of 30% classified as low near miss answer and the response message is limited to "Good" finally a match below 30% is considered as a wrong answer.

However if the student makes a mistake, the tutorial immediately responds with an audible cue, and then gives the student another chance to correct their answers. If the student enters a second incorrect answer, the system will provide the correct answer and continue the tutorial.

V. PILOT STUDY

Domain

The domain used to script the CA is concerned with teaching the students at the age (10-12 years old) the three principals that every Muslim must learn which is to know Your God (Allah), his messenger (prophet Muhammed), and the religion of Islam, with the supportive evidences (Quran and Hadith). Scripts consisting of a context structured according to the main topics in Islamic religious such as the pillars of Islam (Faith or belief in the Oneness of God, Establishment of the daily prayers, etc.). Abdullah CITS is therefore designed to deliver the Islamic topics to learners in classical Arabic language while the learners converse in MSA.

Experiments

Twelve participants were asked to revise their knowledge of Islamic topics by completing the online Abdullah CITS tutorial. The scenario is described as follows: Each participant will engage in a tutorial conversation within one of the three Islamic fundamental by answering a set of tutorial questions that cover different contents in the selected topic. The participant will move from one context to another in a goal oriented structure. Two sets of experiments were undertaken to measure the participants learning over the session. The first experiment where based on Log File to record the dialogue, timings, knowledge and other behavioral factors were analyzed to assess each

learner's performance during the tutoring session. Each log file comprises of two components:

- The classification component records the classification of the user utterance (as show in Table I section A). Utterance classifications were devised in order to make Abdullah CITS reply with responses which were appropriate to the user's utterance's type.
- The Log component is used during the development stage of the CA for debugging and improving CA scripts, allowing adjustments to rules and patterns to be made. (as described in Table I section B).

Table I. Log file classification

A.classification components	Description
7- Question utterance	User utterance that includes an interrogative word
8- Statement utterance	User utterance that give an information, or describe something
9- Response utterance	Abdullah the tutor can tell whether the utterance is a response to a question related to the tutorial
10- Answers classification	<ul style="list-style-type: none"> • highly corrected • partially corrected • near miss answers
5-Quran utterance	verse in Quran
11- Agreement & disagreement utterance	<ul style="list-style-type: none"> • Agreement utterance • Disagreement utterance (have a disagreement word)
12- Utterance not valid	<ul style="list-style-type: none"> • Not belonging to a topic • Not written in Arabic language • Empty utterance ,or have a special character • Have one or more impolite word
B. Log components	Description
13- Selected topic	the session is started by a random topic selected to user; User will then move from one subtopic to another until the end of session
14- Fired Rule	The rules that fires during the conversation, will help to maintain if the user following the right progression path for the tutorial.
15- Response Classification	two levels of responses that's the high level and low level response
16- Current Context	Will help to maintain if the user following the right path for the tutor.
17- Rejects Utterance	The number of times that the user cannot produce a result with enough confidence (ex. When user says: It could be, or I think, etc.).

18- Timing	<ul style="list-style-type: none"> •timing in each interaction during the conversation •Timeouts
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The second experiment will base on the user feedback after participants had completed the tutorial. The participants were asked to complete a short user evaluation questionnaire, to evaluate the learner experiences in using Abdullah CITS, and to assess existing Islamic knowledge. The feedback questionnaire consists of eight questions to be rated using a five-point scale, four questions requiring a Yes/No answer, and three open questions. The tutoring success was evaluated in terms of participant experiences reported in the feedback questionnaires.

VI. RESULTS AND DISCUSSION

The results of the two experiments conducted as part of the pilot study can be found in Figure 4. They show the transcript of the tutoring dialogue of one participant. The experiments show that Abdullah CITS can successfully directing a tutoring conversation by asking the participants to think about the correct datatype rather than simply telling them the answer.

1-Abdullah: Welcome to Abdullah the tutor, please write your name
2-User: my name is Mariam
3-Abdullah: Dear sister Mariam welcome to the program, do you like to converse about the prophet Muhammed? Do you know where he is born?
4-Mariam: Makah
5-Abdullah: excellent, Muhammed (pace be upon him) born in The Year of the Elephant in Makah. What is the secret beyond this name the elephant?
6-Mariam: Abraha wish to demolish Kaaba
7-Abdullah: excellent, Abraha, the ruler of Yemen, marched upon the Kaaba with a large army, which included elephants, intending to demolish it. So does the army demolish the Kaaba?
8-Mariam: No they can't
9-Abdullah: Good, the elephant is said to have stopped at the boundary around Mecca, and refused to enter (**Quran:** Have you not considered, [O Muhammad], how your Lord dealt with the companions of the elephant? (1) Did He not make their plan into misguidance?), do you know The First Verse of the Qur'an?
10-Mariam: The Verse of the Al-Fatiha
11-Abdullah: I think the right answer is, the Verse of Al-Alaq (**Quran:** Recite in the name of your Lord who created - (1) Created man from a clinging substance. (2)). do you know how the beginning proselytizing or preaching of Islam was?
12-Mariam: Secret
13-Abdullah: excellent, Muslims worship first years of Islam in a secret way. Do you know where is the prophet going?
14-Mariam: Kaf, Ha, Ya, 'Ayn, Sad.
15-Abdullah: Quran ([This is] a mention of the mercy of your Lord to His servant Zechariah), can you please answer my question (Do you know where is the prophet going?)
16-Mariam: who's Hinduism?

17-Abdullah: Hinduism is the predominant religion of the Indian. Can you please answer my question (Do you know where the prophet is going?)

18-Mariam: to al Madina

19-Abdullah: excellent, In 622, Muhammad and around 70 Meccan believers left Mecca for sanctuary in al Madina. Do you know what the first battle in Islam was?

20-Mariam: the battle of Badr

21-Abdullah: excellent God bless you, The Battle of Badr was a key battle in the early days of Islam. Do you know what was the second battle in Islam?

22-Mariam: the Battle of Hunayn

23-Abdullah: The Battle of Hunayn was fought between Muhammad and his followers against the Bedouin tribe of Hawazin. can you please answer my question (Do you know what was the second battle in Islam ?)

24-Mariam: I don't know

25-Abdullah: The Battle of Uhud, in 625, Abu Sufyan ibn Harb, King of Mecca. Once again led a Meccan force against Medina. What was the next battle after Uhud?

26-Mariam: Battle of the Confederates

27-Abdullah: excellent God bless you, Battle of the Trench or (Battle of the Confederates) the battle that was Surrounding Medina in 627 , and the results Decisive Muslim victory , During these battles God helps Muslims by angels whose they fight with against non-Muslims. What was the last battle during the prophet period?

28-Mariam: I don't like angels

29-Abdullah: Dear Mariam be careful. God says in Quran (Whoever is an enemy to Allah and His angels and His messengers and Gabriel and Michael - then indeed, Allah is an enemy to the disbelievers). Can you please answer my question (what was the last battle during the prophet period?)

30-Mariam: Conquest of Mecca

31-Abdullah: excellent God bless you, Mecca was conquered by Muslims on 11 December 629 AD

Figure 4. Dialogue

Table II. Utterances classification

Participant Interaction #	Utterance classification
2	Name is : Mariam M/F : F
4	Partially correct answer
6	Partially correct answer
8	Near miss answer
10	Wrong answer
12	Partially correct answer
14	Quran
16	Question Not related to Topic
18	Partially correct answer

20	Correct Answer
22	Statement Related to Topic
24	Don't know Answer
26	Correct Answer
28	Negative Statement
30	Correct Answer

The participant interaction number and the Log file utterance classification are displayed in table II. Figure 4 shows Abdullah CITS was leading the tutorial so the first sentence was delivered by the CITS asking the participant to enter his/her name. The user was entered Mariam and, the system has recognized the name as a female name and continued to converse with the user (Mariam) in a female conversation style (interaction 3 shows that Abdullah CITS using the word Sister for the user Mariam). The system also picked a random topic to start the tutorial (knowing your prophet Muhammed), and began by asking a provoking question (do you know where the prophet was born). Mariam answered the question by writing the word (Makah). Abdullah dealt with this utterance as a correct answer and gave an encouragement message to the participant (Excellent) then continued onto the next question. As the tutorial progress, Abdullah continues to recognize the user's utterance and give different levels of encouragement (interaction 9 & 21). In addition, Abdullah also uses supportive material in the session like (chapter 105 verse 1-3, and chapter 96 verse 1-3) from the Quran (interactions 9 and 11). Interaction 14 asks the participant to write a verse from Quran instead of writing the answer to the previous question (interaction 13). Abdullah has then responded with the next relevant verse from Quran and repeated the same question again (interaction 15). This illustrates the goal –orientation which is built into the system as a learner must answer a question in the tutorial before progressing. Interaction 16 demonstrates the participant asking a question. The system then provides an answer to the question and also repeats the previous tutoring question (interaction 17) to keep the participant on the tutoring path. Interaction 22 shows that the participant gets the wrong answer for the previous question, but the participant's answer shows a related fact to the topic (Table II show that's interaction 22 it's not an answer, but a related statement to the topic), Abdullah sends a declaration response to user and repeats the previous question to give the user another chance to get the right answer. Abdullah can get the utterances that reflect a misunderstanding facts by the user, interaction 28 state that the user (Don't like Angels) the system here send a warning message combined by an appropriate verse from Quran back to user (interaction 29).

The initial pilot study showed that Abdullah was well received, understandable and helpful. 85% of the user would use a CITS like Abdullah to support classroom tutoring, 20% stating they use Abdullah instead of face to face teacher. Only 30% of learners agreed that they would use the Abdullah CITS instead of reading a book.

VII. CONCLUSIONS AND FURTHER WORK

This paper has presented the novel architecture and Arabic Scripting methodology for developing Abdullah the Tutor CITS. The developed tutor aims to teach students the basic fundamentals of Islam allowing a conversational tutorial to take place in both modern and classical Arabic language. Pattern matching technique implemented in the Arabic CA because it's been consider being an ideal solution for a Conversation agent based on Arabic language. PM solves the complexities of understanding the Arabic language, by simply matching the utterance with a set of scripted patterns. Further work will entail an evaluation with students in primary school using more in depth tutorial scenarios and an educational based assessment which can be delivered in a classroom environment.

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The Application of Learning Theories into Abdullah: An Intelligent Arabic Conversational Agent Tutor

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Abstract: Intelligent tutoring systems (ITS) are computer based learning systems, which can adapt to learners' current knowledge and skills, provide the necessary feedback when mistakes are made and provide consistent tutoring any time, 24 hours a day. This paper outlines the research and development of a CITS named Abdullah focusing on the novel application of learning theories. Abdullah CITS is a software program intended to converse with students aged 10 to 12 years old the essential topics in Islam in ordinary natural language. The CITS aims to mimic human Arabic tutor by engaging the students in dialogue using Modern Arabic language (MAL), allowing conversation and discussion with verses in classical Arabic language (CAL), utilizing supportive evidence from the Quran and Hadith. Abdullah CITS is able to capture the user's level of knowledge and adapt the tutoring session and tutoring style to suit that particular learner's level of knowledge. This is achieved through the inclusion of several learning theories implemented in Abdullah's architecture, which are applied to make the tutoring suited to an individual learner. There are no known specific learning theories for CITS therefore the novelty of the approach is in the combination of well-known learning theories typically employed in a classroom environment. This makes the tutoring session less rigid, more adaptive, and capable of delivering personalized learning. The system was evaluated through end user testing with the target age group in schools in Jordan and the UK. The initial evaluation has produced some positive results, indicating that Abdullah is gauging the individual learner's knowledge level and adapting the tutoring session to ensure learning gain is achieved.

1. INTRODUCTION

Arabic language is the tool which carried the Arabic culture since the old period until the approach of Islam, when Arabic became the most important language in the Islamic world. Arabic language is an official language of more than twenty countries, and a major spoken language by over 300 million people worldwide (Habash, 2012). There are two forms of Arabic language, which are the modern standard Arabic (MSA), and the classical Arabic language (CAL). MSA is used in everyday language, in the media, education, and literature (Ryding, 2005). MSA is mainly derived from CAL, which is the standard form of the language used in the holy Quran, the religious text for Muslims (Ahmad, 2011). Intelligent Tutoring Systems (ITS) are adaptive educational systems that employ intelligent technologies to provide individualized instruction, by adapting to learners' skill level closely to individualized lesson provided by the system (Ghadirli and Rastgarpour, 2013c). The main goal of an ITS, is deliver knowledge by mimicking a human tutor through a computer-based system.

Developing a

CITS for the Arabic language faces many challenges due to complexity of the morphological system, non-standardization of the written text, ambiguity, and

lack of resources. However the main challenge for the developed Arabic CITS is how the user utterances are recognized and responded to by the CA, as well as how the domain is scripted and maintained (Alobaidi et al., 2013). This paper focuses on a novel methodology with regards to implementing learning theories within Arabic CITS to adapt the tutoring session to suit the individual learner's level of knowledge related to the tutoring subject. This ensures that a more holistic approach to the tutoring session is implemented making the Arabic CITS more adaptive and engaging throughout the tutoring session based on the learners interaction. This paper is organized as follow: Section 2 will describe the Arabic conversation agent, Section 3 describes intelligent tutoring system, Section 4 describes the learning theories and methods of learning, Section 5 introduces the Abdullah CITS, Section 6 describes the experimental methodologies, Section 7 will discuss the results, and section 8 will conclude and highlight areas for further research and development.

2. ARABIC CONVERSATIONAL AGENT (ARABIC CA)

A Conversational Agent (CA) is a software program intended to converse with a human in natural language (Crockett et al., 2011). CAs have been used effectively in many applications, such as database interfaces (Owda et al., 2011), student's debt management guidance (O'Shea et al., 2010), and computerized learning (D'Mello et al., 2010). Two forms of Conversational Agents have been developed, that being, 'Embodied CAs' and 'Linguistic CAs'. Embodied CAs are a form of intelligent user interface, that can communicate with a user using verbal and paralinguistic (André and Pelachaud, 2010), while Linguistic CA's handle conversation in written or spoken forms (Yin et al., 2010). Existing CA's can be categorized according to the development process into three main approaches: These approaches are Natural Language Processing (NLP) (McNamara et al., 2013); short text semantic sentence similarity measures (STSM) and Pattern Matching (PM) (O'Shea et al., 2010). NLP based CAs focus on translating user utterances and then determine the best actions to respond to user. Arabic language theoretically has a number of limitations, it consider a language of complexity and ambiguity (i.e. Arabic word might have more than one meaning or the sentence might have more than one structure). Consequently, for the above mentioned reasons, the NLP approach is not suitable to build a CA based on the Arabic language (Monem et al., 2008). The second approach is STSM measures. STSS can be used to measure the semantic similarity between short texts of sentence length (10 -25 words long) (O'Shea, 2012). In order to build a CA based on STSS a number of resources are required, such as an appropriate Arabic Wordnet (AWN) (Boudabous et al., 2013). AWN is only available for Modern Arabic language. However the lack of resources as well as the ambiguity of the Arabic language (such as Morphological and Syntactic ambiguity), led the researchers to adopt the traditional approach for building a CA using pattern matching techniques. Pattern matching is considered as being a good solution for text-based CA's as they do not require grammatically correct or complete input (Hijjawi, 2011). Text-based CA's use a form of pattern matching in order to organize their scripts into contexts consisting of a number of rules which themselves consist of a number of patterns and a stimulus response pairs in the CA's knowledge base. A rule is the subtopic that belongs to a context that a user utterance may be matched with a given rule in a given topic related to the context of the discussion. A rule can have a number of different patterns that might be matched with a user's utterance. Patterns consist of a collection of words and a wildcards, which are used to match a portion of the user's utterance (Alobaidi et al., 2013).

3. INTELLIGENT TUTORING SYSTEM (ITS)

Intelligent tutoring systems (ITS) are computer based learning systems, which assists learners in their learning process. The main goal of the ITS is to provide the benefits of one to one instruction automatically and cost effectively (Sottolare and Proctor, 2012). ITS typically have four main components, which consist of the domain model, learner model, tutor model, and interface model. The domain model contains all the elements required to represent the knowledge to the learners, such as the strategies or theories (i.e. education theories), taking all the possible steps to solve a problem, evaluate learner's response, and identify errors (Huertas and Juárez-Ramírez, 2013). The learner model can track the learners understanding for the learner, it can make the right decisions to adapt the tutoring session and guidance for the learners (Abdelsalam, 2014). The tutor model or pedagogical model, is the model that is concerned about the instructional methods, such as choosing an appropriate teaching methods that suit each individual learner (Sani and Aris, 2014). In an intelligent Graphical User Interface (GUI) is responsible for communication and interaction with learner and the CITS, and to control the screen layouts of the system (Ghadirli and Rastgarpour, 2013c). Conversational interfaces to ITS can add more naturalization to the tutoring, allowing students to experience cooperative problem solving similar to with a human tutors. Using a CA interface to an ITS has shown some success in learning, for example:

- AutoTutor is a CITS that assists the student in actively constructing knowledge, about computer literacy and Newtonian physics through discussion (Cheng et al., 2013). The main goal of the AutoTutor CITS is encourage students to show lengthier answers to questions that exhibit deep reasoning such as (answers to why, how, what-if questions), while directing the students towards constructing a solution (Graesser and McNamara, 2010).

However, the Arabic conversational interface to ITS is a new area of research. To our knowledge, no academic research exists on the conversational intelligent system based on the Arabic language.

4. LEARNING THEORIES AND LEARNING METHODS

Learning theories focus primary on how the information is achieved, organized, and recalled (Groff, 2013). According to the cognitive information process theory there are a number of techniques been used to simplify the learning such as, Gagne's learning theory (Gagné and Gagné, 1985), and Piaget's learning theory. This section will describe each of these learning theories, and method in more detail.

4.1 .Gagne Learning Theory

Gagne's theory focuses on intentional or purposeful learning, which is the type of learning that occurs in school (Gagne et al., 2005). This type of learning follows a sequence of steps starting from gaining the attention of the learner to recall of prior learning, to connecting to previous knowledge, and finally to transfer of knowledge to the long-term memory (Gagne et al., 2005). According to Gagne's theory there are nine instructional events, which should be fulfilled to provide the necessary conditions for learning (Kruse, 2010). These events are (Gain attention, identify objective, recall prior learning, present stimulus, guide learning, elicit performance, provide feedback, assess performance, and enhance retention).

4.2 Piaget's Learning Theory

Piaget's theory of learning is considered one of the most accurate theories which defines a child cognitive state (Piaget and Mussen, 1970). Piaget's theory is considered more important when teaching the younger age groups (2-11 years old), as it helps to determine how much and in what way the learner will understand the topic being taught (Kim et al., 2014). Piaget's theory is used in ITS as a support tool on many domains (Stipek, 2013). It has been used as a helping guide for the learner by giving the learner the information they request, based on their knowledge in the taught domain (Carmona and Bueno, 2007).

4.3 Storytelling Learning Method

Storytelling is one of the most powerful and simplest methods for learning. The use of stories in education has been found to be most useful in language learning, such as religious subjects, and for encouraging students to share personal experiences (van Gils, 2005). Interactive digital storytelling through multimedia is a valid educational tool to teach literacy and narrative skills and has been shown to excite people about learning (Yang and Wu, 2012). However, stories must also be learner designed, in that they need to be tailored for the specific audience they are delivered to (Mokhtar et al., 2011). In most religious texts, such as the Quran, storytelling is the natural way in which information about fundamental beliefs is taught (Moll, 2010).

5. ABDULLAH CITS

This section provides a brief overview of the Abdullah CITS (Alobaidi et al., 2013). Abdullah is a novel conversational intelligent tutoring system, which can ask questions and offer problem-solving support rather than simply presenting the answers.

Abdullah was designed to model a human tutor by directing a tutoring conversation.

5.1. Abdullah CITS Architecture

The proposed framework for Abdullah CITS consists of three main components as shown in Figure 1. These are: the ITS (to personalize teaching according to individual learner's characteristics such as the knowledge of the subject, and the behavior), the knowledge base (to provide the sources/material of the learning topics), and the CA (to lead the tutorial through natural language dialog).

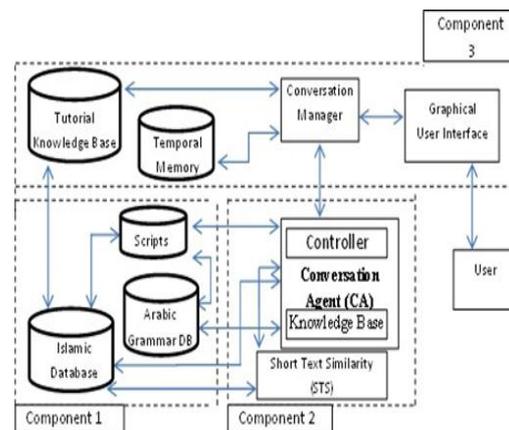


Figure 1 Abdullah CITS Architecture

5.2. Implementing Learning Theories to Abdullah CITS

The Abdullah CITS incorporates a number of learning theories and methods such as, Gagne theory of learning, Piaget theory of learning and storytelling learning method to deliver the tutoring session. The main aim behind the implementation of these learning theories is to make Abdullah a more like a human tutor. The theories allow Abdullah to adapt and adjust the tutoring session based on the learner's interaction with the system. Abdullah is able to capture several variables to gauge the user/learners level of understanding and perception in relation to the tutoring subject. The variables are used to adapt the session to most suit the learner and apply the different learning theories, and ensure some level of learning gain. The next section will outline the implementation of these theories into Abdullah CITS and how Abdullah utilizes them throughout the tutoring session.

5.2.1. Application of Gagne's Theory into Abdullah CIS

Gagne's theories outline a number of instructional events, which are briefly described along with a description of how they are applied in Abdullah CITS.

5.2.1.1. Gaining Learners Attention (reception)

Capturing learning attention is considered the first and the most important process for learning. Two techniques have been used to deal with this event in the design of Abdullah CITS:

- A graphical user interface (GUI) that begins with an animated title screen accompanied by sound effects, to increase children's visual orientation (Marco et al., 2009).
- Each lesson will start with a thought-provoking question or interesting fact about the selected topic to be taught, curiosity motivates students to learn (Li, 2013).

5.2.1.2. Informing Learners of the Objective (expectancy)

To help the learners to complete the lesson and to achieve the goal of the presented topic, the learning objective must be listed early in each tutoring session. In Abdullah, CITS an initial image is displayed at the beginning of the tutorial describing that on completion of the lesson, the learner will have:

- A brief understanding of the topic (the selected topic).
- A link to all the supportive evidence for the topic (Quran and Hadith).

5.2.1.3. Stimulating Recall of Prior Learning (retrieval)

Associating new information with prior knowledge can facilitate the learning process (Gagne et al., 2005). A simple way to stimulate recall is to ask questions about how well the learners understand previous concepts or the body of contents in general. However, all the tutorial questions are organized in the Tutorial Knowledge Base as questions with answers in a default style (A normal basic question which designed to suit different level of learner's knowledge), or as questions with answers in basic detailed style (A type of questions for the learner's with low level of knowledge). During the tutoring session, Abdullah CITS will measure the

understanding of the tutoring topic by the learner by counting the number of correct default and detailed answers. The learner's knowledge will be measured during the tutorial by a variables, an example of such variables are:

- The percentage of the correct answers.
- Whether or not the learners ask, a question related to the main topic.
- Have the learners provided any information using CAL (i.e. a verse from Quran or Hadith). This would indicate a high level of understanding.

5.2.1.4. Presenting the Tutorial Content

The tutorial content is designed to include all the necessary information the learner requires in order to achieve the learning outcome. The learning contents of Abdullah CITS were organized based on the book of monotheism, which is used in primary school education for learners in years 3, 4 and 5. This book has been printed and organized by the Ministry of Education in Saudi Arabia (Al-Sadan, 2000). The topics were then structured using knowledge engineering, and involving a real expert teacher. Subsequently Gagne learning theories were applied to give the tutoring a better structure to ensure effective learning was applied through the Abdullah CITS. In accordance with Gagne's and Piaget's learning theories, the system utilizes a variety of media to appeal to different learning styles; media such as text, graphics and audio as show in Figure 2.

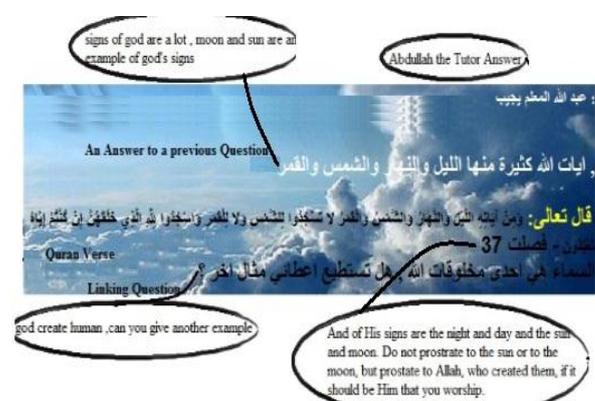


Figure 2 Abdullah CITS

5.2.1.5. Providing Feedback (reinforcement)

As learners practice new topics it is very important to provide specific and immediate feedback on the learner's performance. The Abdullah CITS will display an appropriate encouragement after each correct answer, partially correct and low near miss

answers. As an example, a match of 80% between utterance and pattern script is classified as a correct answer and Abdullah CITS will respond with a message like “excellent God bless you” (Alobaidi et al., 2013). It also can provide an appropriate response in case of learner’s bad behavior, or wrong attitude about the contents of the tutoring lesson.

5.2.2. Implementation of Piaget’s Theory in Abdullah CITS

Piaget diagnoses the cognitive processes of the learners through a number of highly interactive tasks aimed at learners aged 8-12 years old. Piaget theory is implemented in Abdullah, through the determination of the learner’s level of perception and understanding related to the domain. Based on domain related understanding, a response is provided suited to that learner knowledge level. Abdullah CITS implements some interactive tasks such as learner’s promotion, confusion detection (Anglo and Rodrigo, 2010), and hint selection (Ferguson et al., 2006). Each of these tasks will now be defined along with an explanation of how they are applied in Abdullah CITS.

5.2.2.1. Learner’s Promotion

Learners with a high level of cognitive development require fewer problems to solve than a learners with low level of cognitive development (Roll et al., 2011). For that purpose, Abdullah CITS is designed with a number of questions allocated for each sub topics covered during the tutorial. The learners will only be allowed to move from one sub topic to another when most questions related to sub topic been answered correctly (more than 80%).

5.2.2.2. Confusion Detection

Learners with a low level of understanding require more time to solve problems, than learners with high level understanding (Felder and Brent, 2005). Thus, during the tutorial if the learners are identified to have a low level of understanding if they take a long time to answer a question. In this scenario, Abdullah CITS assumes that the learner is struggling with the tutoring content or the learners have not understood the question. Therefore, Abdullah CITS will either rephrase the questions or present the question with an illustrated media like (picture, or sound) to help the learner.

5.2.2.3. Hint Selection

Learners with a low level understanding require more concrete visual hints, while the learners with high-level understanding need more abstract hints (He et al., 2009). As with the confusion detection, Abdullah CITS produces hints in the form of pictures and sounds to help the learner answer the question.

5.3. Storytelling in Abdullah CITS

Abdullah CITS implements a story telling based learning strategy allocated to support the adoption of knowledge to the learner. Abdullah is able to generate multimedia presentations to tell the stories that are related to each topic in the tutoring session using a mixture of natural language, pictures and sounds (Rahimtoroghi et al., 2013). Furthermore, the tutoring content is structured and presented in way that groups the entire learning context into related sub topics. This ensure that each tutoring session has related content which promotes recall and transfer of knowledge into long term memory (Banaszewski, 2005).

6. Experimental Methodology

This section will describe the experimental methodology to test the ability of Abdullah CITS to provide an effective tutoring session. The tutorial that was given by Abdullah CITS was based on the Islamic education modules, to teach the three branches of Islam for the selected age group (10-12 years old). However, the Abdullah CITS tutorial model is suitable for any students that are fluent with the Arabic language, and have little previous experience with the fundamental principles of Islam. None of the participants in the evaluation had any previous experience of using Abdullah CITS. The sample size consisted of 58 participants in total (38 from UK and 20 from Jordan). The sample included both genders, and the participant ages were ranged between year 5 and 6. The participants were categorized into a number of groups:

- Group 1: 10 participants year 5 (Jordan)
- Group 2 : 10 participants year 6 (Jordan)
- Group 3: 22 participants year 5 (UK)
- Group 3: 16 participants year 6 (UK)

During the tutoring /interaction, students were randomly presented with one of the three branches of Islamic religion (to know you God, to know your prophet, and to know your religion of Islam) as the tutoring topic. Each student followed an individualized/customized learning path depending on his or her current knowledge, behavior and dialogue during the tutoring session. During the tutoring session several variables were captured (e.g. students questions, answers, and behavior) and

recorded, for further analysis to predict the success of the tutoring session. At the end of the tutoring session, students were asked to complete a usability questionnaire. The data gathered from the experiments was analyzed to determine how well Abdullah CITS helped to improve the tutoring in the taught subject. Section VII will outline the three experiments designed to test the following hypotheses.

Hypothesis 1: *The success of students in a particular tutoring method is indicative of participant's knowledge improvement in the taught subject.*

As a teaching/learning aide, does Abdullah CITS make any progress to the students' knowledge on the taught subject?

Hypothesis 2: *It is possible to adapt to the student's knowledge level from the tutoring discourse with an intelligent tutoring conversational agent.*

A CITS can monitor students learning progress, in order to and adapt the tutoring to suit an individual learner's level of knowledge?

7. Results and discussion

The data gathered from the experiments was analyzed to determine how well Abdullah CITS helped to improve the tutoring in the taught subject. There were two experiments designed to test the hypotheses in the previous section. The results and analysis of the experiments designed to answer the hypotheses are outlined in the following sections.

7.1. Experiment 1: Tutoring Success

This experiment tests the hypothesis H1, and is conducted to test the tutoring success of the Abdullah CITS. This experiment is based on the log file that records the dialogue between the user and the system. A number of objective and subjective metrics (illustrated in Table 1), were used to verify if Abdullah CITS led to satisfactory learning results).

Table 1 Experiment 1 Metrics

Metric to be Evaluated	Mode of Evaluation	Subjective / Objective
Pre and Post Test	Log file	Objective Metric
Answers classification	Log file	Objective Metric
Completion Time	Log file	Objective Metric
Quality of tutorial	Questionnaire	Subjective Metric
Tutoring content	Questionnaire	Subjective Metric

The generalized linear model (GLM) has been employed in this experiment to analyze the score of pre-test and post-test between different factors (i.e. year group, location, and gender). The results suggest a strong statistically significant relation, (p value less than 0.001) between the students score before the tutoring (pre-test) and after the tutoring (post-test) scores. There is a significant difference (p value equal to 0.001), between the students in year 5 and the students in year 6, independent of the students location (UK or Jordan). There is also a significant difference (p value of 0.023) between the students in the UK, and the students in Jordan. During the tutoring Abdullah CITS recorded a value between, 1 to 3 for each response that is answered correct, and then calculate the accumulative average for each sub topic until the end of the tutoring session. The log file record the score value (Highly corrected, partially corrected, and near miss answers).The accumulative average for each branch will compare against the best accumulative average. As an example the first branch cover 15 subtopics and assuming that student got the highly corrected answer for each subtopic, that will give a value of 45 as the best accumulative average for first branch at the end of tutorial. Comparing the best accumulative average for each branch against the observed values gave percentages of (67.78%, 72.35%, and 58.26% for the first second and third branches respectively). Completion time is an important metric for most dialogue systems, and can be measured in terms of how much time, a given task takes to complete (Forbes-Riley and Litman, 2011). The log file captured the completion time of each tutoring branch delivered to the user. This time was used as a metric in order to gauge the student level of

knowledge and understanding and used in future tutoring branches to adapt the learning style in order to increase tutoring success. The quality of tutoring was examined after the Abdullah CITS tutoring session has ended by giving the students a questionnaire which aims to find out whether they are learning from the tutoring session with Abdullah CITS or not. Tutoring quality was examined after the students are rating the questioner, such as the question (Do you agree that there are too much to learn in one tutorial?). The questionnaire results show that the students are quite happy about the information content that was given by Abdullah with a percentage of 44.8% stated they have a neutral feeling about the learning content in the tutoring session. 13.8% of students were not happy with amount of information in the tutoring session. Tutoring content was examined by asking the students (Does Abdullah the tutor overload you with information?). Students in general found Abdullah CITS not overloads them with information, the majority of students from the whole sample have a neutral feeling (58.6%), a quarter of the students (25.9%) are happy, and (15.5%) of the students felt not happy when rating this question.

7.2. Experiment 2: Adaptability to Student Knowledge Level

This experiment tests the hypothesis H2 (It is possible to adapt to the student's knowledge level from a tutoring discourse with an intelligent tutoring conversational agent). Hypothesis H2 was tested based on a number of metrics recorded from the log file as well as user questioner, as shown in Table 2.

Table 2 Experiment 2 Metrics

Metric to be Evaluated	Mode of Evaluation	Subjective / Objective
Answers classification	Log file	Objective Metric
Questions classification	Log file	Objective Metric
Quality of tutorial	Questionnaire	Subjective Metric
Quality of teaching	Questionnaire	Subjective Metric

The log file Results are used for measuring and evaluating two metrics, which are (answers classification, and questions classification). Answers

classification metrics show that the Jordanian year six students demonstrate more understanding and comprehension to the tutoring topics during Abdullah CITS session than year five UK students, with a strong statistically significant relationship between the two groups (p value = 0.0001). In addition, year six Jordanian students are more likely to recognize the questions been asked in the tutoring session in comparison with year five. The results obtained show a strongly statistically significant difference between the two year groups (p value = 0.00005). Two questions related to H2, were asked to the students subsequent to their interaction with Abdullah CITS, to measure their feeling to support the hypothesis. The first question (Does Abdullah the Tutor provide you with information that you understand?), and the second question (Is it right, that Abdullah the tutor does not provide too much information to remember?). The first question is related to the tutoring content, the results show that the majority of UK students have a neutral feeling when rating this question (48.6%), while there only a small portion of Jordanian students have the same feeling (12.01%). The second question is linked to the quality of teaching, the results reveal that the Jordanian year six students are happier with the teaching from Abdullah (79.4%), compared to the year five UK students (20.6%). From these results, it can be concluded that Arab students who are being taught and practice the Arabic and the Islamic education in their everyday curriculum, and the effect of the Arabic Islamic environment in the Arabic country such as Jordan enjoyed their interaction with Abdullah more than the UK Students who are less exposed to this curriculum.

Conclusion

This paper has presented a novel methodology for implementing learning theories within Abdullah CITS. The aim of Abdullah CITS is to teach the students between the ages of 10-12 years old the fundamentals of Islam, using both modern and classical Arabic language. Gagne learning theory, Piaget learning theory, and storytelling learning methods are implemented in Abdullah CITS to teach new knowledge to students. The results highlighted that the adoption of several key learning theories has made the Abdullah CITS a more intelligent and realistic tutor. The research took a more holistic approach to developing the CITS, in order for the system to be able to cater to a much wider range of

students with relation to their individual learning styles. The results demonstrate Abdullah is able to adapt and adjust the level of the tutoring session in order to keep the student engaged, through adjusting the questions (based on the students understanding), adjusting the material (sounds, picture etc.), and providing feedback (encouragement, and hints). The learning theories implemented in this paper illustrated the benefits of incorporating learning theories to develop an ITS system to make the ITS more effective as a tutor. Through implementation of the well-established learning theories that are used throughout modern education systems into a CITS the student learning experience and knowledge gain has been enhanced. Abdullah CITS was well received by students, who found it helpful, easy to use and successful in improving their knowledge, which was reflected in the results of the evaluation.

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