The Application of Learning Theories into Abdullah
An Intelligent Arabic Conversational Agent Tutor

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Abstract: This paper outlines the research and development of a Conversational Intelligent tutoring System (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 about the essential topics in Islam in natural language. The CITS aims to mimic human Arabic tutor by engaging the students in dialogue using Modern Arabic language (MAL), and 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. 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. 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. 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, 2013). 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 Conversational Agent (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 makes the tutoring session less rigid, more adaptive, and capable of delivering personalized learning to suit individual users' knowledge levels. 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. Abdullah the Tutor is a web based CITS with a CA interface which leads the tutoring session, asking

structured questions, moving from topic to topic in a session and offering intelligent feedback to students. This paper is organized as follow: Section 2 will describe the Arabic CA, 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), and student's debt management guidance (O'Shea et al., 2010). Two forms of Conversational Agents have been developed, that being, 'Embodied CAs' and 'Linguistic CAs'. 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 System (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 (Sottilare and Proctor, 2012). ITS typically have four main components, which are 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, 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 (Abdelsalam, 2014). The tutor 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 is responsible for communication with learner and the CITS (Ghadirli and Rastgarpour, 2013). CA 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 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, an how 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 (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). 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).
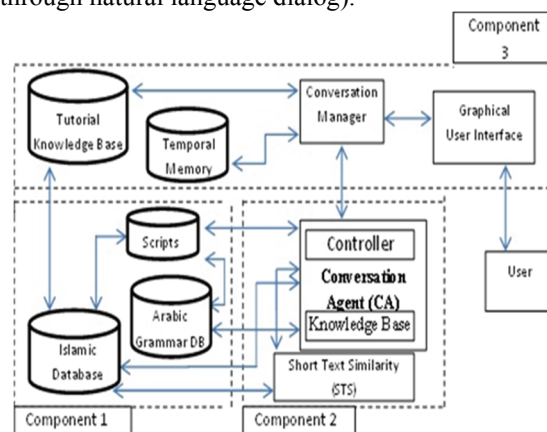

Figure 1: Abdullah CITS Architecture.

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 it utilizes them throughout the tutoring session.

5.2.1 Application of Gagnes 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.

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).

Informing Learners of the Objective

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 leaner will have:

- A brief understanding of the selected topic.

- A link to all the supportive evidence for the topic (Quran and Hadith).

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. Quran or Hadith). This would indicate a high level of understanding.

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.
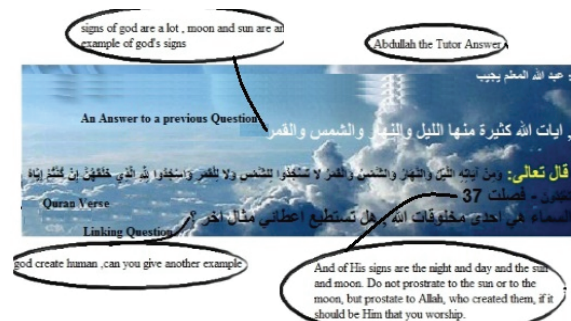

Figure 2: Abdullah CITS.

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.

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. Abdullah CITS implements some interactive tasks such as learner's promotion, confusion detection, and hint selection (Anglo and Rodrigo, 2010). Each of these tasks will now be defined along with an explanation of how they are applied in Abdullah CITS.

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%).

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 (i.e. picture, or sound) to help the learner.

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. 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. 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.

Hypothesis 1: *The success of students in a particular tutoring method is indicative of participant's knowledge improvement in 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.*

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	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 gave 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 braches 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: Experiment 2 Metrics.

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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, and teaching	Questionnaire	Subjective Metric

Results obtained from the log file, have been used for measuring and evaluating two metrics, which are (answers classification, and questions classification). Answers classification metrics show that the Jordanian year 6 students demonstrate more understanding and comprehension to the tutoring topics during the tutoring session than year 5 UK students, with a statistically significant relationship between the two groups (p value = 0.0001). In addition, year 6 Jordanian students are more likely to recognize the questions been asked in the tutoring session in comparison with year 5. The results obtained show a 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 are 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 6 students are happier with the teaching from Abdullah (79.4%), compared to the year 5 UK students (20.6%). It can be concluded that Arab students who are being taught Arabic and the Islamic education in their 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.

8 CONCLUSIONS

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, and Piaget learning theory, and storytelling learning method 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 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 (encourage-ment, 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 implemen-tation 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. The comparison between the UK and Jordanian students shows Abdullah's ability to adapt to the different users abilities, the UK students study Arabic part time, whereas the Jordanian students study Arabic full time. The results demonstrate that Abdullah CITS was able to adapt the tutoring to suit both levels.

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