Applying Robots as Teaching Assistant in EFL Classes at Iranian Middle-Schools

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Abstract - Since its invention, robots have been developed for various purposes and needs, quite similar to personal computers in their early days. However, with the advancement of technology, it is anticipated that in near future one of the cutting-edge technologies to be used in "language teaching and learning" is robotics. Humanoid and/or animal shaped robots will soon gain more attention as a fancy tool for 1st and 2nd language teaching in mid-schools/high schools around the globe. At CEDRA, we are currently exploring the design and application of educational service robots to initiate and pioneer Robotics Assisted Language Learning (RALL) in Iranian schools. With the proliferation of computers and mobile devices, Computer Assisted Language Learning (CALL) and Mobile Assisted Language Learning (MALL) have been in the limelight for 2nd language instructional theories for about a decade or more. However, utilizing robots to support language teaching and learning can certainly enhance today's conventional techniques. Robots not only have the features and interfaces already being employed in CALL/MALL, but are also capable of autonomous movements, visual/voice recognition, and physical/ environmental interactions when equipped with various sensors. Although computers or mobile devices also can be capable of nonverbal communication employing cyber characters/videos, robots are notable in their capacity for nonverbal communication, such as facial expressions, gestures and actions, while coexisting with users in a real environment such as the home/classroom. Additionally, robots are different from computers and mobile devices in a way that they have a friendly appearance and are successfully capable of keeping social relations. This article covers an overview of the subject and our current activities/findings in the interdisciplinary field of RALL in the English as a Foreign Language (EFL) classes and as a case study in the broader filed of Social Robotics in Iran.

Keywords - Social Robotics, RALL, 2nd Language Teaching/Learning, Educational Technology.

I. INTRODUCTION

In recent years, novel applications of Robots in the form of Socially Assistive Robots (*SAR)* have been observed and explored as teaching assistants in a variety of arts and science courses. Since robots tend to capture the interest and imagination of younger students, they have been applied as useful assistants for the teaching of mathematics and physics [1]. This and many other examples clearly show that the use and applications of robots is no longer limited to traditional engineering departments and manufacturing industries, but is distributed across a variety of socially important fields like humanities and medicine. As a result of this novel approach to robotics, the use of robots by non-engineering/ non-technical instructors has been referred to as a "*robotic revolution*" [2]. Due to the rapid development of information and communication technology; teachers, material developers, and educators are trying to keep up with the dramatic changes in our electronic environment [3-6].

Recently working on *Computer Assisted Language Learning* (*CALL*) and Mobile *Assisted Language Learning* (*MALL*) has taken a great leap in the realm of second language acquisition [6-10]. However, since the mid-2000s robots have also been explored as helpful and innovative tools that have come to the aid of language teaching and learning [11-14]. The work presented here focuses on the study of the adaptable social, interactive, and cognitive aspects of robot behavior in an assistive context designed for the young students/individuals seeking to learn English as a 2nd language . In addition to serving as a social and assistive tool, these robots shall also be capable of providing detailed reports of student's progress to teachers/instructors. We shall explore and present a novel system based on the Robotics Assistive Language Learning (RALL) that tries to provide a more flexible and customizable protocol through motivation, culture, encouragements, and companionship to middle school/high school students in their English language courses in Iran. Initial results indicate that this approach can engage the students and keep them interested in interacting with the robot, which, in turn, increases their positive behavior when it comes to language learning and practice. Even-though robots today are generally developed for special purposes, it is hoped that in the near future and with the mass production of humanoid robots

along with costs reduction, great changes will be brought about in the art of language teaching/learning process with the use of robotics technology.

II. SHAPING OF ART WITH TECHNOLOGY

Teaching and learning a language is known to be an interesting art. This art combines science and culture with geographical location to produce a person with greater communication capabilities in demand. As an example, taking a look at the language learning process, learning and retaining vocabulary is known to have a great effect on language proficiency. Furthermore, lack of lexical knowledge has been considered as one of the main obstacles to effective communication [15]. Throughout the recent history of language teaching methods, from audio-lingual method to Communicative Language Teaching (*CLT*), vocabulary was deemphasized and considered of little importance. However, recently more attention has been paid to the investigation of incidental and intentional learning of vocabulary [16], use of visuals for better retention [17-18], application of computer in vocabulary learning/teaching, and the use of *MALL* for vocabulary learning [7-10]. Nonetheless, very few studies have attempted to design and evaluate vocabulary learning with the help of a robot [13]. Their study has concentrated on vocabulary development of a toddler and no studies have been focused on the vocabulary learning and retention of junior/high school students using robotics technology thus far.

A. How Robots Can Help Language/Vocabulary Instruction

The oldest writing systems are known to be between 5,100 to 5,500 years old, [19]. The oldest cave paintings used in communication dates back more than 40,800 years [20]. Humanity was expressed through visual imagery rather than written words for more than 35,000 years. Also, Human desire has always been to replicate itself starting by carving static statues through mechanical dolls to play music in the mid-1700, and present day robots [21, 23-27]. Even today, with complex writing systems at our disposal, people still process visual images more rapidly than text. In the context of studying vocabulary, this has inspired new methods of learning new words, one which turns away from traditional methods and seeks to engage the student's memory in a variety of ways. Humanoid Robots as moving and performing visual objects can be highly effective in transfer of knowledge and certainly enhance the vocabulary learning process for young students. Developing an extensive vocabulary and using the words accurately in speech and writing is a challenge faced by many foreign students learning English as a Second Language (*ESL*).

With humanoid robots as teaching aids, a novel approach to language learning can be anticipated so that young students are able to not only learn new vocabulary words, but commit them to long-term memory with the ability to recall and use them accurately. This is due to the attractive nature of robots that can be programmed to employ and combine definitions with interactive examples to reinforce the new word the student has just learned. By developing and utilizing their intelligence skills through the use of robot, one can expect students to be able to more easily remember new vocabulary. As an example, robots can be readily programmed to play a charade game with students.

B. How Robots Can Increase Vocabulary Retention in Young Students

It is well recognized by all scientists that "communication through language" has been the greatest achievement of the human species. Yet, we are unable to communicate if we lack the vocabulary to do so. Young Iranian EFL junior high school students like many other foreign students learn new words largely through example and experience, and not by learning definitions from a dictionary. They learn new words through communication with their environment. However, at a certain age, less of their vocabulary learning comes naturally, and more of it comes through formal education, learning lists of new words in a classroom setting. Obviously, in order to retain new words and use them correctly, they need to practice them extensively. Utilizing various methods of learning new vocabulary, students are better able to remember and use them correctly. This is due to the fact that the more often the word is used, the more easily it transfers to the learner's long-term memory. Short-term memory has a small storage capacity and simply holds information temporarily. To ensure that the new word is stored in the student's long-term memory, new methods must be used.

It is through the following features and characteristics of robots that make them an ideal teaching aid to support and enhance language instruction alongside teachers: *Repeatability*; the ability to repeat an action many times without getting tired/restless, *Humanoid Appearance*; with a human like appearance robots can be well accepted by students as real teacher assistants which can help to engage and motivate students as well helping to reduce their anxiety level which plays a crucial role in the learning process, *Intelligence*; this feature help robots communicate effectively with human and computers through artificial intelligence, programming, and Wi-Fi systems which preserves many advantages of the previous media for instruction, *Sensing Capability*; gives robots the ability to sense surroundings and awareness of its environment by light/camera sensors (eyes), touch and pressure sensors (hands), chemical sensors (nose), hearing

and sonar sensors (ears), and even taste sensors (tongue), *Flexibility*; the ability of being adjusted to the specific level of the learners, *Interaction*; their ability to interact with students effectively and greatly impact the language learning process, *Body Motion/Mobility*; the ability to move and use appropriate gestures when speaking can also greatly enhance the language learning process, *Adaptability*: robots have the flexibility to be programmed and are capable of being readily adapted/adjusted to the specific level of the learner.

Robots as teaching aids can help defining the new vocabulary and practice them effectively with the student so that he/she can understand the sense of what is being conveyed. This method obviously is superior to cramming a vast amount of information into his/her short term memory, as it provides the learner with the opportunity to fully integrate new words into his/her own vocabulary and retain them for long term use.

A recent trend in vocabulary teaching/learning has been to apply multiple ways of learning new words, such that students can perceive the input through as many channels as possible in order to reinforce the new vocabulary in his/her mind. Therefore it is important to include a variety of stimuli in teaching. One should also recognize that what works the best for one student may not always work as well for another (Dunn and Griggs: "Learning style is the biologically and developmentally imposed set of characteristics that make the same teaching method wonderful for some and terrible for others") [22]. Since students learn in a variety of ways, it is important to include multiple methods a student can take in their study of vocabulary. While some students with equipped with *RALL* may get motivated and gain quicker and more in depth knowledge from conversation practice and interactive experience with robots, other students may benefit just as well from visual stimulation, tangible objects and/or flashcards. Due to different learning styles, each student may benefit more from a specific type of information. With *RALL* system, which will be discussed in further detail later, many different options are available to the student.

The main concept behind the development of *RALL* in vocabulary teaching/learning is the idea of artificial intelligence and robotics which are interlinked with the instructional material and are made to perform the role of the native speaker in the classroom. With conventional methods, there is more emphasis on written definitions and examples. Images are occasionally used, especially in *EFL* or *ESL* texts, but not to a comprehensive degree. Most often they are used to depict objects, scenes, or easily illustrated actions or emotions.

C. What is RALL?

In countries which English is considered a foreign language, various methods are being used to help the learners become exposed to real-life environment. Direct collaboration with a native speaker has been proven to be the most effective way of instruction [6]; however, in the absence of a native speaker, utilizing computer or mobile based applications in the classroom may seem the second best choice. Yet, due to the limitations of computers and mobile systems in engaging students and providing an interactive environment other sources of technology have been looked into. Among the fastest growing technologies that have proven to be of benefit to the language learning process are robots. For example, while the idea of creating multiple forms of examples for each word is appealing, it is also a terrorizing task. Teachers often lack the time and patience that is required to create meaningful examples for long vocabulary lists. By employing a *Robotic* system as teaching assistant and resource available to them, they will be able to teach vocabulary in new ways, using the previously programmed humanoid robot to reinforce the vocabulary lessons they give their students in the classroom. *Robotics Assisted Language Learning (RALL)* does not seek to replace teachers in the area of vocabulary instruction, but rather to assist and supplement their lessons and reinforce the material that is being learned by repeated practice. *RALL* can offer this help in a variety of ways. While similar concepts have been studied, only a few systems have been developed such as intelligent methodology for language teaching and learning [5-6, 11]. Depending on the number of words saved with premium content in the *RALL*'s base computer, multiple methods to teach a new vocabulary can be experienced in classroom/home environment with the humanoid robot acting like a live talking dictionary. Like any fine human teacher *RALL* provides the student with the option to question and request vocabulary explanation. Robot assistant may provide the learner with not only the word and its definition, but also an example sentence, an audio clip of the word's pronunciation and description. Robot descriptions and audio/interactive entertainment serves as a memory aid to further reinforce the meaning of the new word in the student's memory. It is well known by the experts in the field that the brain processes visual interactions with moving objects or human more rapidly, and some people are better learners than others, when live interaction reinforces the meaning of the word. An intelligent *RALL* system equipped with voice command/recognition and vision capability can provide an opportunity for discussion, and prompt students to

think of the word or concept in their native language and make associations with the English word. One other option for *RALL* can be the advanced quiz capability. Teachers or students can create quizzes based on pre-set word lists, or create their own unique sets of words. Learners can have the option of quizzing themselves using words, images, definitions, or example sentences. These *RALL* quizzes reinforce the words the student is learning, and will continue to re-use the same words until they have been answered correctly. With such an integrated system, it is easy for students to create quizzes that match with the words they have been studying.

A well designed *RALL* system is ideal for use by a variety of individuals: junior high school students, teachers, *ESL* and *EFL* students, and students who are studying vocabulary for a variety of standardized tests. For teachers, it has many advantages, as it is an interactive tool and can be used to stimulate classroom discussion and reinforce concepts and words learned in class. It is believed by the researchers in the field that the more opportunities a student receives to practice new vocabulary in multiple formats, the better he/she will be able to retain it. We believe that exposure to the vocabulary by the *RALL* system may increase the likelihood of retention, which in turn improves the student's overall vocabulary bank and improves his/her ability to communicate effectively.

III. THE RALL METHODOLOGY

A. Participants

This study attempts to examine the effect of a *RALL* system on the vocabulary learning and retention of Iranian *EFL* junior high school students in a private school in Tehran. Fifteen female students between 12 and 13 years of age, studying in their first year of junior high in a private school will participate in the *RALL* study group. They will all participate in a placement test beforehand and all those who are at the beginners' level will be chosen for the study. The students are then assigned to the *RALL* class. This class will be using the English book devised by the ministry of education for 7th graders and the vocabulary taught and tested will be taken from that particular book. The treatment will take 5 weeks.

B. The Robot Instrument

The present study will use the following instruments to collect the necessary data. The main instrument used in this study is a kid-sized, autonomous, programmable, humanoid robot *NAO* developed by Aldebaran Robotics (Fig. 1), [23]. We have renamed this robot to *NIMA* (a Persian name) for better interaction with Iranian students.

The height of the robot is 57.3 cm, width and depth of 31.1 cm and is 27.5 centimetres, respectively. It also weights 4.3 kilograms.

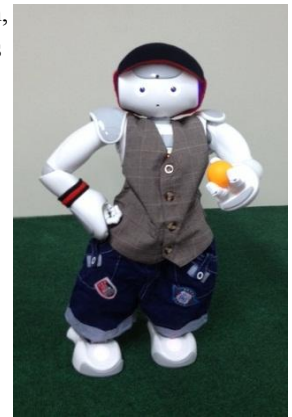The robot used for this study was the Robocop version of NAO which has the following features:

Fig.1. The NAO (*NIMA*) Robot [23].

- Body with 21 degrees-of-freedom with key elements as electric motors/actuators.
- Sensor network, including 2 cameras, 4 microphones, sonar rangefinder, 2IR emitters and receivers, 1 inertial board, 9 tactile sensors, and 8 pressure sensors.
- Various communication devices, including voice synthesizer, LED lights, and 2 high-fidelity speakers.
- AMD GEODE 500MHZ CPU (V3.3) (located in the head) that runs a Linux kernel/supports Aldebaran's proprietary middleware (NAOqi)
- Second CPU (located in the torso).
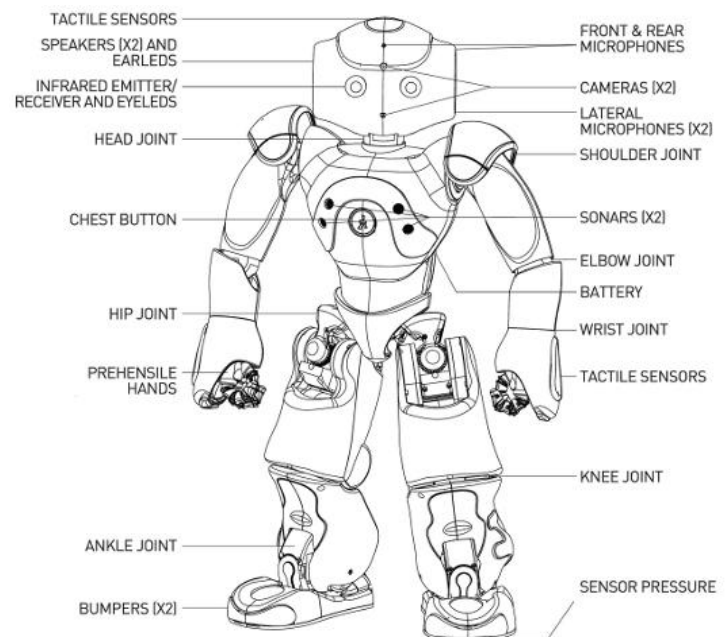- 27.6-watt-hour battery that provides NAO with 60 to 90 minutes of autonomy, depending on usage.

Fig. 2. Schematics of the NAO (*NIMA*) Robot.[23].

The NIMA Robot has the following abilities and resources to be used in the classroom (Fig. 2):

Motion: NIMA is capable of Omni-directional walking and whole body motion. It also has a fall manager that protects it when it falls. He can walk on a variety of floor surfaces, such as carpeted, tiled, and wooden floors.

Vision: NIMA has two 920p cameras which can capture up to 30 images per second, and can track, learn, and recognize images and faces. The first camera, located on NIMA's forehead, scans the horizon, while the second located at mouth level scans the immediate surroundings. The software lets you recover photos and video streams of what NIMA sees, but eyes are only useful if you can interpret what you see. He can recognize who is talking to it, with the ability to be developed for more complex features.

Audio: NIMA uses four microphones to track sounds, and its voice recognition and text-to-speech capabilities allow it to communicate in the default languages that are defined on its system. One of the main purposes of humanoid robots is to interact with people. Sound localization allows a robot to identify the direction of sounds. The NIMA robot can also apply the following applications; all of which can be useful in the language learning process.

- Human Detection, Tracking, and Recognition
- Noisy Object Detection, Tracking, and Recognition
- Speech Recognition in a specific direction
- Speaker Recognition in a specific direction
- Remote Monitoring/Security applications
- Entertainment applications

Connectivity: NIMA currently supports Wi-Fi and Ethernet, the most widespread network communication protocols. In addition, infrared transceivers in the eyes allow connection to objects in the environment.

Software: The Choreographer is the visual graphical programming language of the robot. It allows the creation of behavior and movements on the NIMA robot. It also has a tool in which created behavior can be tested on a stimulated robot before trying them on the real robot.

A series of pre-tests, post-tests, anxiety tests, attitude and motivation tests will be administered to all participants prior and after each session and the results will be compared and reported accordingly.

C. Design, Data collection and Analysis

This study attempts to use a quasi-experimental design in order to obtain the desired results. The use of the quantitative data in immediate, short term and long term post tests will help the researchers to reach accurate results regarding the retention of the vocabulary items.
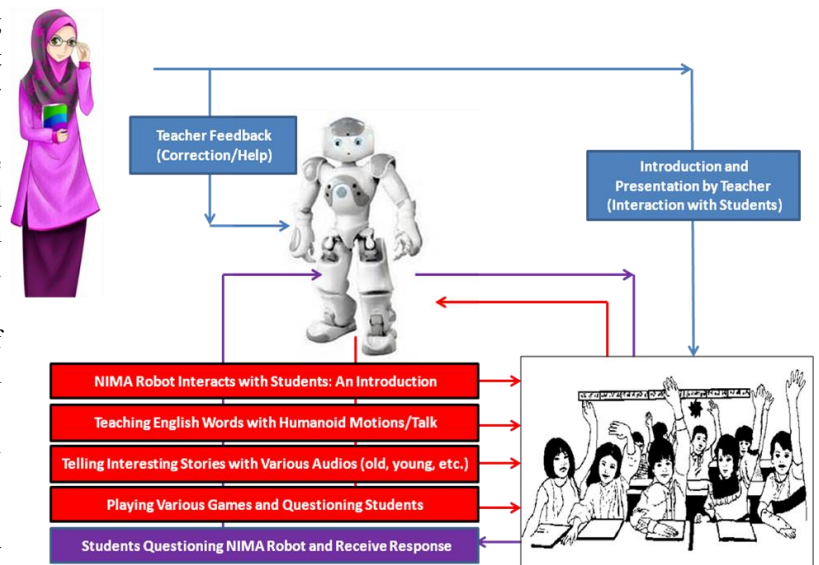

Fig. 3. The lesson plans are devised in a way to enhance the most interaction between the students and the robot.

Fig. 4. A model of the *RALL* classroom in Tehran, IRAN.

Also, considering the importance of different factors such as motivation, anxiety, and attitude on the process of learning, the researchers will use previously used

questionnaires in order to be able to make precise conclusions regarding the process of learning. Our study attempts to evaluate the use of robots in the classroom and its effect on the language learning process. The *NIMA* robot programmed by the robotics group shall play a number of games and tests with the students and the data will be recorded (Fig. 3). For each session a lesson plan will be devised. The lesson plans are focused on vocabulary; however, the teacher will be teaching all the material that is in the book regarding each lesson (i.e. grammar, reading, writing, pronunciation). One hundred vocabulary items taken from the 7th grade junior-high school book will be emphasized on (Fig. 4). The *RALL* lessons are planned prior to the class and they will be practiced beforehand with the robot in the *CEDRA*'s robotics instructional laboratory in order to check and recheck the use of the robot, and to eliminate any possible software problems that may occur. The data obtained from the participants pretest and post-tests (by using SPSS 16 software) will be analyzed using dependent sample t-tests to see if there is any improvement in terms of vocabulary learning among learners. Finally, to evaluate the attitudes, anxiety, and motivation of the learners a descriptive analysis with along content analysis will be used to analyze the results of the questionnaires.

IV. CONCLUSION

Exploring Human-Robot cooperation for English language teaching and learning in Iranian schools have been the main objective of this study. Initial experiments, empirical experience, and a review of recent literatures clearly indicate that a combination of Human-Robot instruction as Teacher-Assistant module will form an intelligent cooperative system that will offer enhanced capabilities over conventional English language teaching methods. Nonetheless, a human-robot cooperative strategy in teaching is also necessary to perform all tasks that cannot be readily executed by just the human-based language instruction. The methodology focuses on applying the robotics assistive language learning (*RALL*) technology to aim at providing personalized assistance, motivation, and near native companionship to young students in Iran as English language learners. With the features and characteristics embedded in many humanoid robots such as repeatability, adaptability, sensing, appearance intelligence, interaction, and mobility, the *RALL* system can establish a productive interaction with the learners, and serves to enhance their interest, motivation, and collaboration in specific tasks/exercises and problem solving abilities.

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