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The Next Wave of Learning with Humanoid Robot: Learning Innovation Design starts with "Hello NAO"

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Today, robotics is a rapidly growing field and has received significant attention in the society. A humanoid robot is a robot that is built based on the human body structure. It is often seen to resemble human behavior and cognition, and manages to perform tasks in a similar way as human being. Humanoid robots are now increasingly used in fields such as education, hospitality, entertainment and healthcare. They are expected to serve as humans' daily companion and personal assistant. The paper reports a work-in progress pilot study that design the learning innovation with humanoid robot, NAO. Rule-based reasoning and progress test design are developed and recommended. The learning innovation programs has been developed based on the design and pilot tested at the learning and teaching at Monash University Malaysia. Future work and recommendation are discussed in innovative technology engaging learning.

Keywords: learning enhancement, Nao robot in education, IT education innovation

1. Introduction and Literature Review

Today, robotics is a rapidly growing field and has received significant attention in the society (IEEE, 2015). One of the various types of robots is the humanoid robot. A humanoid robot is a robot that is built based on the human body structure. Most humanoid robots have a torso with a head, two arms and two legs (Roebuck, 2012). It is often seen to resemble human behavior and cognition, and manages to perform tasks in a similar way as human being (Aoyagi & Shirase, 2009). Humanoid robots are being developed for scientific research purpose. Besides research, humanoid robots are now widely used in other fields such as education, entertainment and healthcare (George, 2015). They are expected to serve as humans' daily companion and personal assistant. Some robots act as a teaching assistant for elementary school students (Han & Kim, 2009). One of the humanoid robot, NAO, which is released in 2008 by Aldebaran Robotics, a French robotics company. The latest generation of NAO is the NAO V5 Evolution launched in 2014 where the functionality has improved for better interaction between the robot and humans (Inbar, 2014). NAO has a powerful and fully programmable platform with various sensors and language capabilities. Recently, NAO has been widely used around the world for research and education purposes. "In more than 70 countries, he was used in computer and science classes, from primary school through to university. Thanks to NAO, students can learn programming in a fun and practical

way." (Aldebaran, 2015). NAO can be a true daily companion; it can sing, dance, play music and talk to people. Based on the comparative review (Chua, 2015), it was found that NAO robot is the best choice of all the humanoid robots to be recommended to use in enhancing learning and teaching with the following justification: (1) Language capability: It can speak up to 19 languages; (2) Mobility: It is small and light, easy to carry everywhere by lecturers or students; (3) Cost effectiveness: It is affordable, a lot cheaper compare to other expensive robot such as ASIMO (2015) and iCub (2015); (4) Sensors capability: It has all the general abilities needed to interact with the students and lecturers in a fun and humanoid way; (5) Durability: Its battery life can stay longer; (6) Programmable and logic design: It has a powerful and fully programmable platform; (7) Attractiveness and motivation: It creates "wow effect" for learning and teaching practitioners and further motivates to engage students with learning.

2. The Next Wave of learning Innovation Design

It is reported that an intelligent robot NAO, developed by one of the EU leading companies, Aldebaran is claimed to be 'a star in the world of education' and being used in more than 70 countries for learning and teaching (Total Education, 2014). On the other hand, there are gap between student expectations and university learning and teaching. Students are complaining that the classroom today is boring and not engaging. Students are using mobile devices extensively but the traditional lectures remain Powerpoints and lecturers (Chew & Kalavally, 2014). In addition, a growing number of researches argue that modern technologies are causing concentration problem in the class. According to recent survey conducted by Pew Research Centre with almost 2500 teachers in the Unite State, they found that 87% of them felt the digital gadgets have created an "easily distracted generation with short attention spans" (Jeffries, 2013). Hence, the aim of this work-in-progress research is to thoughtfully integrate NAO robot in traditional class room setting to increase students' engagement and assist lecturers to enhance effectiveness in reaching their teaching experience.

In addition, a research suggests the lack of students' independent problem solving and communication skills are pervasive in the pool of Malaysia Engineering and IT graduates (Tan, 2015). Students are taught and assessed in the same way the lecturers were being taught two decades ago. The need for rethinking and redesigning the learning and teaching. Since NAO has a powerful and fully programmable platform with various sensors and language capabilities, the paper presents a design and implementation that aimed to enhance learning and teaching experience with the innovative use of NAO. Attracting and developing new generations of engineering and IT experts and conducting scientific research with NAO for seamless learning is the design principles. Engagement and motivation is the key driver for the design science of NAO in introducing IT and Engineering education. In addition, enhanced learning and teaching experience such as cross-curriculum, hands-on and interactive learning, multi-language programming environment and implementation are the expected outcomes.

Figure 1: NAO V5 Evolution

2.1. Robot Model and Program Development

The model of NAO robot used in this project is the latest version, which is the NAO V5 Evolution as depicted in Figure 1 above. The development environment is Python with Choregraphe 2.1 (2015). Choregraphe is a cross-platform development environment designed by Aldebaran Robotics that can implement NAO's actions through logic- and graphics-based programming. It provides the functionality to create NAO robot application which includes the behaviors and dialogs, such as interacting with the audience, singing and dancing. Students can monitor the behavior of the robot using the Robot View feature in Choregraphe. The strength of Choregraphe is that it allows developers to add customised behaviors to or further mechanisms of the robot using their own Python, C++ or Java code. An educational program with Q&A section with NAO is developed and pilot tested in two teaching subjects: one undergraduate (with 240 students) and one postgraduate subjects (with 6 students). Students' engagement were observed and reflected.

2.2. Design principles and Limitations

The design principles for learning and teaching innovation are as follows:

(1) Developing the "Factbase " using User Stories
- This will facilitate the Q & A sessions between NAO and students.

(2) Developing the interpreter for the rules [inference engine]: recognizes and executes a rule-based system whose conditions have been satisfied. This control is data driven (forward).
- the interpreter of NAO robot, voice-to-text recognition engine need to be programmed with IF-THE-ELSE conditions to let NAO understand the conversation.

(3) Developing the Rule-based: Sample of algorithm, Activity Diagram & Description of Design

(4) Developing the NAo education program to send out email to students or lecturers for the engagement activities and scores.

However, the learning materials and facts (data) in NAO robot might be outdated. Hence, data need to be updated frequently. Also, students might feel difficult to interact with NAO robot if this is their first time speaking with a humanoid robot. Therefore, a user manual guide needs to be provided. NAO might not understand what the students or lecturers say if their pronunciation is inaccurate or their voice is unclear. Thus, NAO should be able to react to the users and ask them to repeat their words. NAO can only recognize one voice at a time. If there are multiple voices at once, he cannot interpret the voice correctly and hence, causing voice recognition problem. Wireless Internet connection is also another major constraint. NAO will react slower and its voice recognition will become less accurate if the wifi connection is weak. Hence, it is important to have a strong Internet connection to connect NAO with the computer that controls it.

3. Initial Observation and Reflection

The learning innovation with NAO has been piloted in two teaching units, one first year degree programming subject and one master business information system subject. These are some preliminary observations:

1. Not all student in the large student cohort of undergraduate subject (240 students) were engaging fully throughout all 2 hours class. After introducing NAO in teaching in the mid of teaching, The students' engagement is tremendously high comparatively. All students were paying full attention during the Q&A session with NAO for explaining respective knowledge.
2. The learning with NAO experience at the postgraduate subjects (with 6 students) level is similar. Students were prompted and energised to see NAO and engage with the learning process.
3. There is an impression that the lecturer + students + power point is equal to a 'boring lecture'. With the use of an interactive 'live' technology, NAO, students are motivated to learn and participate in the discussion and debates.
4. Both students' engagement and motivation are disrupted and enhanced by introducing NAO in the class. This phenomenon will be declined after the 'exciting moments', as those were the days the first time power point or mobile teaching were being introduced. More importantly, it is the design principles and best practices to embed NAO in enhancing learning experiences. These are the research gap to be investigated.

The learning engagement paradigm has shifted from manual engagement to personal response system, and now with NAO. With the invention of robotic technologies in the 21st century, innovation in higher education using intelligent robots has become a challenging but transformative research in design and implementation. Students can learn the educational experiences in higher education with the human-NAO interactions. The design of proposed NAO programs enable students to practically connect theory with practice through problem solving, question and answers and high level of motivation for futurists' perspectives. For programming subjects, students can design the algorithm and apply the programming concept to a moving robot than a static system / website / mobile apps. The level of learning engagement and experience is much enhanced.

We believe that the next wave of learning innovation no longer lies at e-learning or mobile learning but, thoughtful integration of face-to-face learning with humanoid robot. The future work is to expand the innovation to more teaching units in School of IT at Monash University Malaysia and to design a framework of introducing learning and teaching with NAO based on the larger scale of experimental research. User experiences from both

students and lecturers will be investigated. The level of learning engagement and motivation, enhancement or disruption of independent learning will be explored in the future work.

4. Concluding Remarks and Recommendation

With the invention of robotic technologies in the 21st century, innovation in higher education using intelligent robots has become a challenging but transformative research in design and implementation. Students can learn the educational experiences in higher education with the human-NAO interactions. The design of proposed NAO programs in section II enable students to practically connect theory with practice through problem solving, question and answers and high level of motivation for futurists' perspectives. The learning innovation with NAO has been piloted in two teaching units. The future work is to expand the innovation to more teaching units in School of IT at Monash University Malaysia. User experiences from both students and lecturers will be investigated. A comparative study between teaching IT and non-IT subjects with NAO can be explored. We believe that the next wave of learning innovation no longer lies at e-learning or mobile learning but, thoughtful integration of face-to-face learning with humanoid robot.

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