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

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Today, humanoid robotics research is a growing field and humanoid robots are now increasingly being used in the area such as education, hospitality and healthcare. They are expected to serve as humans' daily companion and personal assistant in including in education. On the other hand, students may complain that the classroom today is boring and not engaging. Students are using mobile devices extensively but the traditional lectures remain PowerPoints. Is there a educational synergy for integrating a humanoid robot in daily teaching? Responding to the needs, the paper reports a work-in progress pilot study that designs the learning innovation with humanoid robot, NAO. Initial experiences are reported. Rule-based reasoning and progress test design are developed and recommended. The educational program is 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

Introduction and Literature Review

Today, robotics is a growing field that 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 to perform tasks in a similar way as human being (Aoyagi & Shirase, 2009). Humanoid robots are also being developed for scientific research purpose. In addition, 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 famous humanoid robots, NAO, is released in 2008 by Aldebaran Robotics, a French robotics company (Aldebaran, 2015). The latest generation of NAO V5 Evolution launched in 2014. The functionality has improved for a better interaction between the robot and humans (Inbar, 2014). NAO has a powerful and fully programmable platform with various sensors and language capabilities. NAO is 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" (Aldebaran, 2015). NAO can be a true daily companion; it can sing, dance, play music and talk to people. Based on the comparative review by Chua (2015), it is found that NAO robot is the best choice of all the humanoid robots to use in enhancing learning and teaching based on the following justifications: (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 a "wow effect" for learning and teaching practitioners and develops further motivation to engage students with learning. With these functions, there is a high potentiality that NAO robot can be used to enhance learning and teaching for IT undergraduates and postgraduates. Generally, IT students are more demanding for technologies in learning and assessment. However, it seems to have another form of 'digital gap' between students and educators where educators may not meeting IT students' expectation of blending educational technologies in class (Hiew & Chew, 2015). We need to thoughtfully explore and design the next wave of learning innovation, possibly with the aid of NAO robot.

CP:52

The Next Wave of learning Innovation Design

It is reported that an intelligent robot NAO is claimed to be 'a star in the world of education' and is 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 may complain that the classroom today is boring and not engaging. Students are using mobile devices extensively but the traditional lectures remain the use of Powerpoints and passive lecturers (Chew & Kalavally, 2014). In addition, a growing number of researches argue that modern technologies may cause concentration problem in the class. According to a recent survey conducted by Pew Research Centre with almost 2500 educators in the Unite States, they found that 87% of the educators feel that 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 explore the thoughtfully integration of NAO robot in traditional class room setting to increase students' engagement and learning experiences. These are the proposed research questions: (1) Can NAO enhances student learning and engagement experience, and how? (2) What are the design principles for NAO educational program?

In addition, a research suggests that there is a lacking of students' independent problem solving and communication skills 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. There is a need for rethinking and redesigning the learning and teaching. Since NAO robot has a powerful and fully programmable platform with various sensors and language capabilities, the paper presents the design and implementation of NAO educational program that is aimed to enhance learning and teaching innovation experience. 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 education. The enhanced learning and teaching experience such as interactive learning, multi-language programming environment and NAO educational program implementation are the expected outcomes.

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. 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 behaviours and dialogues, such as interacting with the audience, singing and dancing. Developers 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.

Figure 1: NAO V5 Evolution

Methods, Design principles and Limitations

An educational program with Q&A sessions on NAO is developed and pilot tested in two teaching subjects: one undergraduate (with 240 students) and one postgraduate subjects (with 6 students). The NAO educational program we developed consists of interactive concept/ theories explanation and Q&A sessions. There is only one robot in the class that a lecturer can use for teaching more complex concepts and to engage students for interactive Q&A. Lecturers brought NAO to the class and integrated the newly developed NAO educational program in teaching and assessment. Students' engagement were observed and reflected.

The initial design principles for developing the NAO educational program for learning and teaching innovation are as follows:

(1) Developing the "Factbase " using User Stories (e.g. challenging concepts / theories to teach with Q&A)
- This will facilitate the interactive teaching and 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 interactive teaching and Q&A.

(3) Developing the Rule-based: Sample of algorithm, Activity Diagram & Description of Design
- The design of Q&A sessions, the flow / selections of the questions and a function to be able to calculate the total scores/ marks for students' understanding and performance of the related topic.

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

However, the above principles need to be further tested in a wider spectrum of subjects and with various students to be generalised. 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 for how to interact with NAO robot. NAO robot might not understand what the students or lecturers say if his/ her pronunciation is inaccurate or the voice is unclear. Thus, NAO robot should be able to react to the users and ask them to repeat their words. NAO robot can only recognise one voice at a time. If there are multiple voices at once, he cannot interpret voices correctly and hence, causing voice recognition problems. Internet connection is also another major constraint. NAO educational program needs to run on NAO robot with Internet connection. NAO robot will react slower and its voice recognition will become less accurate if the Internet / Wifi connection is weak. Hence, it is important to have a strong Internet connection to connect NAO with the computer that controls it.

Initial Observation and Reflection

The learning innovation with NAO is piloted in two teaching subjects, one first year degree programming subject and the other one is a master in business information system subject. These are some preliminary observations:
1. Not all students in the large student cohort of undergraduate subject (240 students) were fully engaged throughout all 2 hours class of teaching. However, the students' engagement is tremendously high after introducing NAO educational program to explain certain concepts. All students were paying full attention during the Q&A sessions with NAO for fun interaction.
2. The learning with NAO experience at the postgraduate subjects (with 6 students) level is similar as described in point no 1. 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 technology and 'lively being', NAO robot, students are motivated to learn and participate in the discussion.
4. Both students' engagement and motivation are disrupted and enhanced by introducing NAO in the class. This phenomenon may decline after the initial 'exciting moments', comparable to those were the days when power point or mobile teaching were first introduced. More importantly, it is the design principles and best practices to embed NAO in enhancing learning experiences matters. These are the research gap to be investigated for future work.

We would argue that the learning engagement paradigm has shifted from manual engagement to personal response system (i.e. clickers), and now with NAO robot. 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 educational programs enables students to practically connect theory with practice through problem solving, fun question and answers and high level of motivation for futurists' perspectives. The level of learning engagement and experience is much enhanced. For programming subjects, students can design the algorithm and apply the programming concept to a moving robot

than a static system / website / mobile app (this aspect is not tested in the pilot study and yet to be explored).

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 the proposed and implementation of NAO educational programs 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 subjects with confirming experiences. The future work is to expand the innovation to more teaching subjects in School of IT at Monash University Malaysia and to design a framework of introducing NAO educational program based on a larger scale of experimental research. 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. The level of learning engagement and motivation, enhancement or disruption of independent learning will be explored in the future work. We believe that the next wave of learning innovation no longer lies at e-learning or mobile learning but, a thoughtful integration of face-to-face learning with humanoid robot.

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Note: All published papers are refereed, having undergone a double-blind peer-review process.