Humanoid Robots Attending Lectures – Research Informed Teaching

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ABSTRACT
The University of Hertfordshire aims to support a research-rich environment that informs teaching. As part of the University's strategic plan it would like to encourage students to develop an understanding of the history and role of research in computer science. In all of our computer science degrees at the University we teach a module called Contemporary Issues in Information Technology. Within this module we have included a lecture called "The Rise of the Robots". We invite one or our resident robots, Pepper, to take part in the lecture. Pepper can talk to the students, answer questions about the module and even invite them to dance. In this paper we will describe our experiences of using Pepper in lectures and how we have used this as a way to engage students in the research process and encourage research skills. It is sometimes claimed that defenders of research-led education have limited evidence to support its effectiveness. Our work will contribute to this debate. The work is in its embryonic stage and we welcome comments and feedback.

CCS Concepts
•Computing Profession → Assistive Technologies •Social and Professional Topics→Computer Science Education

Keywords
Research Informed Teaching; Robotics; Human Robot Interaction (HRI); Student Engagement

1. INTRODUCTION
For the past 15 years, the University of Hertfordshire's Adaptive Systems Research Group [1] has focused its work on artificial life and rehabilitation and assistive robotics, with expertise in neurorehabilitation robots, robot-assisted play, and socially assistive robots.

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The University of Hertfordshire aims to support a research-rich environment that informs teaching. As part of the University's strategic plan it would like to encourage students to develop an understanding of the history and role of research in computer science. The Adaptive Systems Research Group in Hertfordshire is a multidisciplinary group of faculty, students and research staff of the University of Hertfordshire who carry out research in the field of Adaptive Systems. Adaptive Systems are systems that adapt via learning, evolution, development or via more subtle kinds of interaction, involving social interaction and/or embodiment. The group works in the areas of artificial life, social robotics, virtual agents and environments and emotion modeling. One group is studying the social rules needed by a robot to provide a comfortable interaction with humans [2] and to gain their trust in order to allow robots to look after their well-being. Rossi et al. [3] are investigating the impact of different magnitude and timing of errors on humans' trust in social or no-social robots. The robot's orientation toward the human whom it is interacting with can show caring and attention [4]. To enable adaptive behavior, a robot needs to recognize the proximity and be able to distinguish the touch gestures between interacting individuals. Syrdal et al. [5] used a Pioneer robot showing dog-inspired affective cues to communicate affinity and relationship with humans using proxemics, body movement and orientation, and camera orientation. Koay et al. [6] studied participants' preferences for the robot's approach distance. Chanseau et al. [7] investigated the sense of perceived and desired control of humans for a domestic task made by a companion robot. Forster et al. [8] used a iCub robot to acquire the human-like use and understanding of negation in linguistic utterances.

Other research uses robots to help the rehabilitation of patients that need physical therapies, such as stroke patients. Robots can deliver a large number of repetitions in training exercises without suffering fatigue. One of the application areas of the group that has been studied since 2003 is the development of smart home and home companion robotics technology, to allow older people to stay for longer independently in their own homes. Research concerns technology development as well as methodological advances in scenario development and evaluation, see e.g. [9][10][11].

The University has a robot house which is used in Human-Robot-Interaction (HRI) research. The robot house contains a variety of robots including Care-O-Bot, a companion robot [12], Baxter, a light industrial stationary robot with two manipulator arms which can move objects and also CHARLY, (Companion Humanoid Autonomous robot for Living with You). CHARLY can be used as an avatar to provide a physical presence at a remote location. There is also a Robocup football team "Bold Hearts". RoboCup is

the greatest robot competition in the world, more than 40 countries participating, including the Bold Hearts team. The teams are composed by fully autonomous robots that play games of 2 halves, with kicking, dribbling, passing, scoring, and goalkeeping. The robots are not remote controlled and take decisions by themselves (it looks like walking football). The overall goal is to beat the human FIFA World Cup winning team in 2050. There are also two Humanoid robots, iCub (developed at Istituto Italiano di Tecnologia - IIT) and Pepper (developed at SoftBank-Aldebaran Robotics). We used Pepper in this study. Another robot of the team is Kaspar (see Fig. 1). Kaspar is a humanoid robot that helps to improve the lives of children with autism. This robot, that has been developed at the University of Hertfordshire, is used in several schools, nurseries of specialist early learning centres, in family homes and hospitals around the UK. Therefore the School of Computer Science has a long history of research into Robotics, however, this research has not been explicitly introduced to the students although they can choose to study some of the Artificial Intelligence modules we provide at undergraduate and postgraduate level. Students who don't choose these modules can often complete their degrees without having any knowledge of the School's research into Robotics.

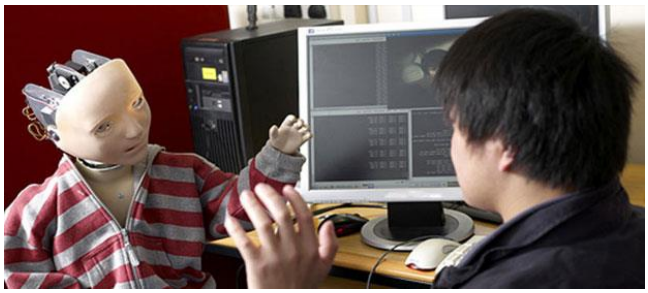

Figure 1. Kaspar –Humanoid Robot to help children with Autism.

As part of the University's strategic plan it would like to encourage students to develop an understanding of the history and role of research in computer science. The University would like to support a research-rich environment that informs our teaching. In the School of Computer Science we have an ideal opportunity to engage students in the current Robotics research and catch the students' imagination with the robots.

2. PEPPER THE ROBOT

Pepper is an autonomous robot designed and built by Softbank Robotics and Aldebaran Robotics. Pepper was launched in 2014. It is a human-shaped robot, however its resemblance is stylized and not close to a real human (see Fig. 2 [1]). The robot has 20 degrees of freedom (6 motors in each arm, 2 in the neck, 2 in the hips, 1 for the knee, and 3 for the wheels) and omni-directional wheels. It has several sensors, speakers and microphones. Pepper has also several touch sensors on its body and LEDs (e.g. around the eyes). The robot has a 10.1-inch touch screen user interface and WI-FI and Ethernet connections.

These features combined with the functionality of detecting and analysing humans' emotions allows to design a natural and intuitive Human-Robot Interaction (HRI). Indeed, Pepper was developed as an emotional robot that is able to detect emotions and autonomously adapt its behaviors to the humans' mood. The robot has been used in several stores in Japan and Europe as shop-assistant and in a Japanese home as human companion [13].

However, similar to the NAO robot made by the same company which has been used in several educational studies [14][15][16], Pepper has the great potential to act as teacher from infant schools to universities, and specialized schools. The intention is not to replace teachers or teaching assistant, but to enhance the learning experience. Tanaka et al. [17] provides an application in which the children learn both together with and using Pepper in their home from a human teacher who gives a lesson from a remote classroom.

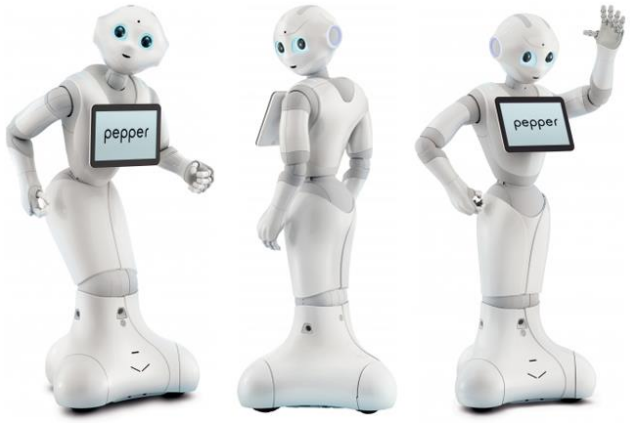

Figure 2. Pepper.

3. RESEARCH INFORMED TEACHING

Given our expertise in the field of robotic research we have an ideal opportunity within the School to explore ways we can use robots in learning and teaching and undertake inquiry related to research rich and research informed teaching to help operationalise the Education and Research strands of the University's strategic plan [18] and add to existing work in the area. The importance of research in underpinning the curriculum is not new. In the 1990s Ramsden and Moses [19] examined the associations between research and teaching and argued that good university teachers had to be actively engaged in research. However, Marsh and Hattie [20]; Webster [21] found no significant relationship between these. That said, in later works Brew [20][21][22] examined the research teaching nexus in an attempt to establish whether or not there is a relationship and as a result found many exemplars of good practice in the Higher Education sector [23][24][25][26] which demonstrates the linkages. Doolan [27] also reports on works conducted by scholars who have long argued that curriculum should be informed by research [28][29][30][31]. What was found to be common amongst these views is that students who are exposed to tutors who themselves are active researchers in their field learn better. Through engagement in authentic and plausible learning in the process of "real world" research Doolan [33] argues that research used in this way informs teaching and learning and benefits student learning.

Doolan [33] claims that given the commercialisation of Higher Education; particularly in the United Kingdom, it is essential for

[1] Image credit: Aldebaran, SoftBank Robotics Corp.

university's to underpin curriculum with research at all levels of study, especially if they are to add value and differentiate themselves from other types of education i.e. training in vocational colleges. As universities adopt a business model for higher education there is a growing concern amongst academics over the casualisation of teaching. This is generally carried out by non-research active teachers as espoused by the Times Higher Education in the United Kingdom [34].This can lead to a two tier university system which may disadvantage those students who are not provided with access to "real-world" research, even if they are taught by teachers who have based their work on research found through other means; for example the literature. Although, most universities would claim that there is a close synergy between teaching and research and indeed, this is included in their strategic plans [18][34][35]. The definition of "research" and "teaching" is contested. Brew [22] for example opposed the descriptions of 'research' and 'teaching' and argued the different interpretations of the terms between academics, disciplines and institutions made it difficult to make claims to the practice of research informed teaching. As a result Healey [29][30] developed a tool to support teachers in bringing closer the research and teaching nexus to help inform practice. This was based on the work of Griffiths [28] and is widely used by universities across the United Kingdom and has been adapted by the University of Hertfordshire to help operationalise the Research and Education strands of the strategic plan [18].

Our approach is supported by Jenkins and Healey's framework of four quadrants representing research-led, research-oriented, research tutored and a research-based mode of teaching. In this project we are involved in research-led and research-oriented teaching. One element from the top axes of the Jenkins and Healey model and one from the bottom.

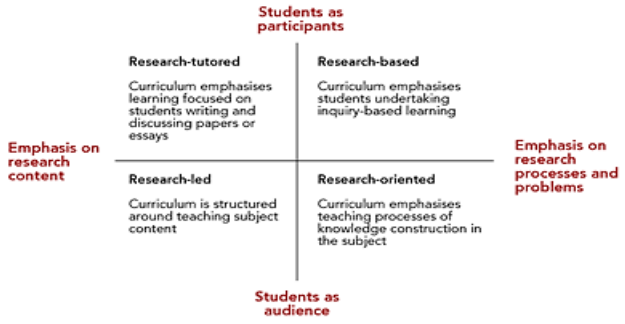

Figure 3. Healey and Jenkins 2009.

For purpose of this project we have used the Healey and Jenkins framework to guide our thinking. They propose four different forms of research informed teaching or learning to strengthen the link between research and teaching. They used two axes one that takes account of the extent to which students are treated as the audience or participants and the other classifies the approach emphasising research content or process and problems.

4. PROJECT PEPPER – WORK SO FAR

Last year we introduced Pepper into one of the lectures for the Contemporary Issues in Information Technology modules. This is a group of over 200 undergraduate students in their second year of a full-time degree in Computer Science or Information Systems. It is a core module which covers the topics required for initial British Computer Society (BCS) accreditation for our Computer Science degrees. The module covers the effects on society of the rapid increase of information technology and covers the issues, knowledge and understanding needed by a professional in the computer industry to support their practice. Some of the topics covered in the module include: an introduction to ethics and codes of conduct for computing professionals, intellectual property, open source computing, computer and network security, the ethics of hacking, Green IT, whistleblowing, the effects of new technology on society and UK legislation as regards the computing industry. [36]

During the lecture Pepper introduced herself and then we did a short presentation on the use of Robots in assistive care and asked the students to consider the ethical issues involved. (After some investigation with the manufacturers we established that Pepper is indeed female; although she also does have the appearance of a child.) At the end of the lecture the students gathered round and asked Pepper questions and watched her dance. (None of the students volunteered to dance with Pepper). We subsequently recorded a lecture for the on-line MSc group in which Pepper starts with telling the students a story (The Three Musketeers) and we then ask the students how they would feel about Pepper telling their children a bedtime story.

After attending the lecture with Pepper ask them how they feel about Pepper being a care robot. In smaller tutorial groups we would like to ask the students what they feel about the ethical issues involved. For example the loss of human contact, how much should we trust the Robots? What if Granny wants to be picked up and thrown off the balcony or given an overdose of pills? Would the robot do this? We are in the ideal position of having a group of 230 students in each year of the cohort. We would like to compile a list of the ethical issues the students come up with in the tutorial and then compare these to the research taking place in the School. In fact we can get the students to do this using their own research skills as we would like some of the students to undertake some qualitative research themselves in their undergraduate final projects. We then go on to consider the ethical issues of using Robots in a care environment and the ethical issues raised by using assistive robots in society[37].

5. RESULTS

At the end of the second year module the module had positive feedback both in student questionnaires and at the programme committee meetings. This was qualitative data and only a small sample. We will enlarge on this in the future study. Student engagement in the module increased and attendance was better than in previous years. This inspired us to think about how we could integrate this into the module for the next iteration and also include more information about the research which the School was doing in the Adaptive Systems Group and also satisfy part of the University's strategic plan for research-informed teaching. At the time of writing we have not yet had feedback from the MSc group. The work is still in the early stages and we hope to continue with a longitudinal study by following next year's second year cohort into their final year.

6. FUTURE WORK

We would like this project to run initially in two of our modules. Firstly, the second-year undergraduate level 5 module called "Contemporary Issues". The second module is an MSc on-line module with the title "Contemporary Issues in Information Technology", again this is a core module and each year has 60-100 students enrolled.

A mixed methods approach would be adopted to capture and analyse both what students say and do and to evaluate the project. Surveys and interviews will be conducted with students about their perception of the value of the approach of research-informed teaching. It would also be appropriate to undertake a later survey to see how the effect this approach may have had on the selection of student projects. Given the appropriate funding and time we would like to make this a longitudinal study. We have a module in the first year called Human Dimensions of Computing where the students study HCI, a module in the second year, previously mentioned, called Contemporary Issues in Information Technology, a module in the third year called Project Planning where the students choose and plan their projects for the final year. At the moment we do have problems engaging the final year students in critical thinking in their final year projects and we plan to carry out and qualitative and quantitative analysis of the students' approach to research over the three years of their on campus teaching to see if there is a change in their choice of topics for the final **year** project and also in the final grade profile. Engaging students in progressive research-informed teaching facilitates the development of critical thinking, teamwork, communication, reflection and problem solving skills and can enhance a student's resilience and employability. [38] Designing the part of the study that investigates the efficacy of the approach would be part of the outputs of the project. It is a non-trivial undertaking and would provide an important means to understand the efficacy of the approach of research-informed teaching. A study has already been undertaken in a small MSc cohort [32] and we intend to build on this.

We will take a case study approach using qualitative and quantitative research methods. Surveys and interviews would be conducted with students about their perception of the value of the research-informed teaching. We intend to follow the 2017 – 2020 cohorts throughout these three modules. It is sometimes claimed that defenders of research-led education have limited evidence to support its effectiveness [39], [40]. Our work will contribute to this debate. The work is in its embryonic stage and we welcome comments and feedback.

7. ACKNOWLEDGMENTS

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