Building Futures:
Using Educational Robots to Teach STEM in a Smart Learning System in Abu Dhabi

Megan Hastie
Al Yasat Private School, UAE

EXECUTIVE SUMMARY

As momentum builds around the fourth industrial revolution, it is imperative that schools equip the youth of today to succeed in the workforce of tomorrow. The use of smart learning environments (SLE) is an optimal way to prepare students for the future because the use of innovative technologies and elements allow for greater flexibility, effectiveness and adaption, engagement, motivation, and feedback for the learner. It is envisioned that the "smart" learners of the future will operate in SLE that are contextual, personalized, and seamless. The learning process in the SLE will facilitate their problem solving and promote their intellectual growth as lifelong learners. This study, then, demonstrates how educational robotics can be used by educators to equip students in the UAE for futures in STEM fields of study and work. It is claimed that students who build robots build futures for themselves and their communities: a worthy goal for Emirati students in 2018, The Year of Zayed.

INTRODUCTION

As momentum builds around the Fourth Industrial Revolution (World Economic Forum, 2018; UNICEF, 2017), it is imperative that schools equip the youth of today to succeed in the workforce of tomorrow. The use of Smart Learning Environments (SLEs), as proposed by Spector (2014), is an optimal way to prepare students for the future because the use of innovative technologies and elements allow for greater flexibility, effectiveness and adaption, engagement, motivation and feedback for the learner. The 'smart' learners of the future, then, will operate in SLEs that are contextual, personalized and seamless, that are designed to prepare them for lifelong learning through the facilitation of their problem-solving and the promotion of their intellectual growth (Zhu, Z.T., Yu, M.H., & Riezebos, P., 2016).

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This chapter seeks to demonstrate how technology, specifically educational robotics, can be used in smart and innovative ways to equip learners for the future in STEM fields of study and work. STEM is defined here as a curriculum based on the idea of educating students in the four specific disciplines of Science, Technology, Engineering and Mathematics, using an interdisciplinary and applied approach.

There are claims that, beyond the 'digital revolution', technology is transforming the physical world and changing the very notion of what it is to be human (Papagiannis, H., 2017). Technological augmentations, such as cochlear implants, are now routinely performed on humans (Hastie, M., Smith, R., & Chen, N., 2012; Dornan, D., Hickson, L., Murdoch, B., Houston, T., & Constantinescu, G., 2010). While the cochlear implant, or bionic ear, represented the first human-machine interface, its invention in 1978 irrevocably blurred the boundary between the physical and digital world. As the age of bionics unfolds, there is increased fusion between our physical and digital worlds (Robotics Research, 2016). At the University of Melbourne in Australia, for instance, a research project is underway that aims to explore and realise the dexterous use of motorised prostheses for the upper limb or hand (University of Melbourne School of Engineering, 2016). Scientific evidence on the ways in which signals between the arm and brain are communicated may allow amputees to regain their sense of touch and increased movement.

Technology is also driving change in global production with new digital tools facilitating 'smart' and greater interconnectivity, monitoring, and efficiency of resource use. However, the speed and scope of such change is adding a layer of complexity to the development and implementation of industrial strategies. The challenge world-wide, then, is to use technology to promote productivity and inclusive growth. In research undertaken by Price, Waterhouse and Coopers (2015) it was predicted that skills in STEM would be required in seventy-five percent of the fastest-growing occupations. For STEM workers, this means they must operate in 'smart' ways to know how to draw knowledge from each of the separate STEM disciplines, that is from Science, Technology, Engineering, and Mathematics, to try to understand how the world works and to solve problems (United States Department of Labor, 2014).

Furthermore, it was forecast that between 2010-2020 in the United States (US), all occupations will see an increase of 14% in STEM jobs (US Department of Education, 2015), with the highest projected increases expected for Mathematicians (16%), Computer Systems Analysts (22%), Systems Software Developers (32%), Medical Scientists (36%) and Biomedical Engineers (62%). If the predictions are accurate, students world-wide will be advantaged by developing 'smart' learning strategies, specifically STEM capabilities, that will 'future-proof' them to compete in an increasingly competitive global marketplace.

Problem Statement

Students in the United Arab Emirates (UAE)need to be able to compete in the global marketplace, and this means they must be equipped for the future in STEM fields of study and work. It is imperative that schools in the UAE prepare students to become the innovative, creative, and systematic problem-solvers of the future that are needed to 'future-proof' their nation. The study reported here was based on the use of 'smart learning' at a school in Abu Dhabi, in the UAE, to accelerate the STEM learning of Emirati students, using educational robotics.

The Emirate of Abu Dhabi was founded by Sheikh Mohammed Bin Zayed, in 1971, and is a young and emerging society, one of the seven emirates in the UAE. The people of Abu Dhabi have enjoyed considerable economic prosperity and wealth based largely on its rich reserves of natural resources, specifically its fossil fuels. Beyond oil and gas (Masdar Institute/IRENA, 2015), the UAE aims to increase its manufacturing share of GDP to 25% by 2025. To achieve this goal, the UAE must continue to

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