Robotics and Its Infusion in Global Education

Literature Review

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Abstract

This literature review will investigate the issue of Robotics and its infusion in global education in various established and developing countries. Around the globe, countries are catching onto the idea that robots can bring positive contributions in learning into the classroom. These revolutionizing teaching methods create an impact on collaboration, communication, and critical thinking in preparing the current students around the globe for 21st century learning skills.

Keywords: robots, robotics, STEM, programming

Introduction

It was not long ago that teachers and students used a new technology in the classroom called a computer as an instructional teaching machine. Now, a unique teaching machine called a "robot" manifests itself into the education system. Starting early on from Pre-Kindergarten all the way through to graduate level courses, robots have infiltrated the education scene as they become more common in our everyday lives. This embraces a diverse field of educational instruction by the means of functionality and simplicity of computer-based programming supporting a variation of different robotic platforms with unique directives (Felicia & Sharif, 2014). Robots and assorted programming platforms and traditional instruction develop the child's mind. Students voyage beyond textbooks by building various types of robots and programming the creation to perform a certain task.

Background

Robotics, innovation for future-focused education learning system, has origins dating back in time. This broad timeline exemplifies certain robot accomplishments (a) 3000 BC to 1920-Egyptian water clock, mechanical wooden duck, Leonardo da Vinci humanoid sketch to the industrial revolution and introduction of term "robot", (b) 1932 to 1957-Three Laws of Robotics (Isaac Asimov), Robbie the Robot, Sputnik, (c) 1960 to 1994-Robot B-9 (Lost in Space), R2-D2 and C-3PO (Star Wars), Carnegie Mellon & Robotics Institute, FIRST Robotics Competition, Sojourner, and (d) 2000 to 2017-da Vinci Surgical System, ASIMO, Roomba, Mobile-Robot Fulfillment Warehouse, Autonomous Car, and DARPA (Risedorf, 2015). And now, within the global education scene and supported by the STEM initiatives, the education system is transforming and creating guidelines to provide access to robots and robotics in the classroom with unforeseen possibilities for the future in global technology.

Robots and Classroom Instruction

A robot is a conglomerate of component parts that include motors, sensors and programs (Robot, n.d.). Each of these components focuses on different fields of expertise such as engineering, electronics, and computer science. This interdisciplinary nature of robots means that when students learn to engineer robots can inevitably direct them to learn about the many other disciplines and career STEM (Science, Technology, Engineering and Mathematics) fields that robotics operate in (Rogers & Portsmore, 2004). Robotics is branch of engineering that involves many 21st Century skill sets such as idea conception, design, mechanics, assembly, and operations of a robot. (Rouse, n.d.). These basic parts allow the student and teacher to sustain maximum comprehension within a lesson and curriculum unit. Adding robot, robotics, and STEM to academic studies at any age level generates excitement within any learning environment.

In addition, curriculum development and investment in training teachers is a vital component in the digital fluency and computational thinking that robotics and robots bring to the classroom. By modifying and restructuring teaching techniques through internet-based collaborations and instruction, the classroom learning and structure will reflect interactive classroom transformation into congenial learning experiences for all. In 2012, Alimisis' study addressed the issues of teacher training in the robotics and science curriculum. The study revealed that initial education courses and followed by shorter in-service training programs for teachers focusing on science training molded authentic real-world problems formulated the technology rich programs in the classroom. In turn, ignited the robust educational experiences in this STEM field, not only for teachers but most importantly the learners.

Impact in the Classroom

In today's education system, traditional and non-traditional applications go hand-in-hand in a classroom-learning environment. A classroom infused with the sound of buzzing student voices and beeping of robots, clicking of gears, rustling of LEGO parts, tapping of an iPad insights constructive chaos in such a way that students are excited and eager to engage, participate, collaborate, discover, listen actively, voice opinions, encourage, take risks, cooperation, solve problems, and instruct are exemplars of successful implementation of diverse robot lessons. These characteristics are very important in the learning process (Hyo-Jeong, 2010).

Integrating Robots and the Technology in Developed Countries

Robots and robotic curriculum based on the STEM initiatives in the United States of America are unfolding into classrooms and adding value by offering new opportunities and creating connections by the students. The developing technology is choreographed to deliver customized instruction for students. Lessons are being derived with the sights on 21st Century learning skills from ISTE (International Society for Technology in Education). With these initiatives, classroom missions encourage investigation, critical thinking, and problem-solving skills. Nemiro, Larriva and Jawaharlal (2015) found that students will advance with much-needed understanding and 21st Century skills in creative thinking and problem-solving and in turn, better prepare them to succeed in college and later on in the professional careers.

Switching to European view on robots and STEM education, a consensus by the majority of the countries, with Germany taking a different stance. A study was conducted in Milan, Italy where the use of educational robots was part of the science education program at the primary level. The benefits from this study concluded that robots provided children with the opportunity

to develop scientific research skills and competencies and to engage in metacognitive reflection on fundamental issues concerning scientific methodology, including the concepts of "explanation", hypothesis" and experiment (Datteri, Zecca, Laudisa, & Castiglioni, 2013). With science and technology becoming very important in the acquired knowledge of our future leaders, not only introducing robots and STEM, but the importance of keeping up with the advancements and moving aggressively is taking the global education world by storm. Additionally, the overall consensus within the European community is that the long-term goal is to make robotics in education stronger, more serious and assessed, creating a sustainability in a global education system, in order to achieve, obtain, and sustain an increasing technology competence of young people and to attract them for technical professional careers (Baxter, Ashurst, Read, Kennedy, & Belpaeme, 2017).

On the other hand, Germany has a quite different view on the perception of robots within their educations system. According to a study by Reich-Stiebert, & Eyssel (2015), "…contrary to previous findings, our results suggest that German respondents have neutral attitudes toward education robot. The study stated there was reluctance among members (teachers) to partake in learning processes that included robots and its' related curriculum. Also noted in the study conclusion is that gender, age, understanding of why and the type of technology created a negative impact in infusing this curriculum in the classroom. Concerning potential areas of application, teachers could picture using education robots in areas related to STEM and rejected education robots in fields of arts and social sciences (STEAM).

Moving to China, where automation and robots are considered the success of the country. The view on robot, robotics, STEM and its' curriculum is very interesting and supersedes many developed and developing countries. Robot education is very important and concurrent with the

Chinese government influence, domination and acceleration into this field. For China to succeed in this, the Chinese Ministry of Education encourages companies to fund STEM and robotic initiatives in the classroom (Wang, 2017). China has in-depth development and involvement of robot education from the onset of toddlers into the primary and secondary schools (Zhang & Zhang, 2008). From the primary school years, the institutions require students to compete in national robot and computer competitions, as part of their education career. Schools, in either impoverished or developed areas carry out robot education through virtual robots. Children in the developed areas have an advantage whereas the classrooms are outfitted to maintain the hands-on learning with the about materials and robots. The courses, both virtual and reality, are interwoven into many curriculum areas but with one small setback, the instructor might not be an "expert" or trained in the implementation of robot curriculum (Zhang, Zhang, 2008). Teacher training is the weakest link in not only in the Chinese classroom but in other countries. This is due to the fact that this is a new and emerging piece of the global education system.

Integrating Robots and the Technology in Developing Countries

Robots, robotics and STEM activities are still at an infant stage in the developing countries of the world. The majority struggling to find the funds, trained staff and space to establish a program dedicated to this evolving learning platform (Zhang & Zhang, 2008). The majority of the developing countries around the world, perceive robots and STEM activities engaging and attractive, and will continue to explore possible alternatives in funding suitable for their education system. There is the need and push, for these emerging countries to become part of competitive in the world, and in order to be competitive this specific education has to be included in the classroom activities. Robot supported educational teachings in developing countries have received minimal global attention than the established countries. This is in part

due to constraints from economic, educational, and political perspectives (DeJusto, Digal, & Lagura, 2012). There are various robot-supported educational undertakings that can be adjusted and directed to include this specific subject-matter such as inclusion of businesses and non-profit organizations in the schools to increase student exposure and present and opportunity for these students to participate in.

Malaysia's stance, according to Felicia & Sharif (2014), "It is vital to explore the usage of robots in teaching and learning, how it works and its effectiveness particularly in the Malaysian context. In addition, the importance of educational robotics and skills involved needs to be identifies…in Malaysian classrooms". There is the potential for robots in Malaysia to facilitate and foster learning by allowing developers such as Lego to become part of the integration in the classroom. The study concluded that the outcomes of pilot program using LEGO robots and its math and science lessons, students increased their scores on PISA and TIMMS (Felicia & Sharif, 2014). Along with the increase in scores, the gender gap decreased, allowing for meaning full collaboration and sharing of ideas that benefit all. Through the data from this study, robot integration can be implemented without restrictions and allowing for very successful designs, meaningful projects and building concrete robots that ignite the educations skills necessary and support the continued use of robots in the classroom.

On another note, in Taiwan, students are not exposed to robots, robotics or majority of STEM curriculum in school. In a study conducted by Eric Zhi Feng, Chun Hung, & Chiung Sui, in 2010, they conclude that even though students have achieved remarkable results in international competitions, they do not have many opportunities to learn about robotics in elementary or middle schools. The majority of the students have exposure and opportunities to learn about robotics through private institutions or after school clubs. The research and development of

robotics for students in Taiwan schools in is not very advanced. Another take away from this study was that there very few trained teachers and projects dedicated to the application of robotics in primary and secondary education, but robotic technologies and applications are heavily found in Taiwan's universities and research institutions. The study also revealed that in schools, robots are referred to as assistive instructional tools that support different areas of the curriculum.

Up and coming developing country, Romania, has increased its' position in the global technology community and has completed this by using robots in its' education system from the primary grades throughout secondary and continuing through graduation from a university (Andruseac & Adascalitei, 2014). The teaching element is strong in that it advocates efficient and practical training tool for teachers in the technical subjects. The designing of the curriculum revolves around the workplace, by taking into consideration that automation is part of the global economy. This study concluded that educational robots have a huge potential as a learning tool and bring to the classroom added value in the form of "stimulating, engaging and instructive teaching aid" (Andruseac & Adascalitei, 2014). Romania's education system has embraced what other developing countries are seeking out, that robotics and education leads to forming a society that consists of leaders that can work with their minds and know how to access and analyze information, evaluate and make decisions to solve world problems.

Conclusions

Robots have funneled their way into the global education system in many different stages and forms. Throughout these world-wide studies, the consensus is that the long-term goal is to make robotics and robotics in education stronger, more serious and evaluated and thus sustainable in order to achieve increasing technology competence of young people and to attract

them for global technical and professional careers (Bredenfel, Hofmann, & Steinbauer, 2010). Besides robots, computational thinking, and real-world problem solving triggers the students' interest and turned, to a certain extent, learning into gamified activities suitable for fostering both creativity and learning excellence in the STEM fields, especially science and technology (Alimisis, 2012). To a certain extent in many parts of the world, robots, STEM and its' curriculum has been reported to be on the increase in the classroom.

Additionally, the teacher role is extremely important as stated throughout many of the studies, to create an atmosphere for students to engage in self-assessment, solve problems, active, engaging, collaborator, ownership and authenticity. On that note, classroom structure and dynamic groupings help students to figure things out for themselves, asking questions, solving problems and taking ownership directly connects to an important life skill. Across the global physical boundaries, there is a universal conclusion that out future leaders need to be able to navigate the world with this skill set, (1) a collaborator, (2) constructor, (3) creative communicator, (4) computational thinker, and (5) innovative designer.

Ultimately, infusion of robots and its' 21st Century skill set is a rising, innovative and formable learning style that enriches the education platform with interactive hands-on lessons, collaboration, problem-solving, and exposure to science and technology field. This utilization includes multiple learning methods and practices. Taking into consideration the diverse global population, these cross-curriculum and multi-engaging activities accommodate, offer solutions, fulfill, and complement learning to support the success of all students. According to results of these studies, the process and implementation is not going to be easy, but in time with additional exposure and understanding of robots and STEM, teachers will attain a certain comfort level to

introduce and combine traditional onsite and interactive online activities to inspire students to be lifelong learners. (Barker, Nugent, Grandgenett, & Adamchuk, 2012).

Furthermore, with today's education system in a multi-faceted transition stage, with inclusion and easy access to the Internet this is the perfect opportunity for computation thinking, robotics, and STEM activities to take a leading role and carve out its own pathway in an effort to attain quality education for each student. Ultimately, with the introduction of robots and robotics in the curriculum, student's interest in engineering, core content standard and STEM with rise (Emily Toh, Causo, Tzuo, Chen, & Yeo, 2016). A common ground approach bring education to the forefront basing on a technology that has no boundaries and requires little more than a child's imagination, authentic hands-on activities that is pertinent to the future success of our global society.

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