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The Business of Educational Robotics

Science, Technology, Engineering and Math (STEM) education is a growing trend in many school districts today. Students in the United States, according to the International Association for the Evaluation of Educational Achievement (2011), are less equipped for the rigors of mathematics and science in high school than students in other countries. Additionally, according to data from the National Center for Education Statistics, the number of students studying computer science declined over the first part of the 21st century (Burke, 2016). Consequently, the development of the *Next Generation Science Standards,* which include content and practice in STEM, are now being adopted by many states (Ortiz, Bos, & Smith, 2015). Young children have a natural curiosity for their surroundings by attempting to build, design and see how things work, making the introduction of engineering instruction and technological literacy crucial in early years (Resnick, 2007). Furthermore, it has been concluded by the President's Council of Advisors on Science and Technology (2010) that the U.S. needs to invest in training programs that ensure preservice teachers have strong content knowledge preparation and training.

In an attempt to level the playing field of U.S. students in math and science as well as encourage girls and minorities to pursue STEM careers, many elementary and secondary schools have introduced robotics programs (Shannon, 2015). "Robots allow students to connect theory with practice and discover a wide range of robotics-related fields, such as computer science, engineering, and mathematics" (NAO robot - Professional development for teachers, n.d.). While schools often incorporate robotics into after school programs and extracurricular activities,

research has shown the positive academic impact of robotics as part of regular classroom instruction (Sullivan & Moriarty, 2009).

According to EdSurge, educational technology has become a big business. In 2015, startup companies in the K-12 sector raised $537 million while higher education raised $711 million from investors (Winters, 2015). The following list of companies has embraced the STEM movement and provide teachers and students with solutions for the incorporation of robotics into educational practice and STEM programs.

Aldebaran - NAO

Created by French company Aldebaran, NAO is a 58 cm tall humanoid robot. First produced in 2006, he has been continually evolving and is currently in his 5th version with 7,000 robots having already been sold throughout the world. Due to its interactive and customizable nature, NAO users can construct their experiences based on their imagination and needs (Who is NAO?, n.d.).

From preschools to universities, NAO not only introduces students to programming but creates engaging and stimulating learning environments. Learning to code becomes more attractive and concrete for older students while learning to count, tell a story or even write holds a fascination with younger students (Who is NAO?, n.d.).

Robots in education, and NAO in particular, help teachers introduce the complexity of mechanics, physics, and programming in engaging and interactive ways enabling them to explain abstract concepts in a concrete manner. NAO naturally arouses students' interest and motivates active participation through projects and teamwork.

Choregraphe, NAO's graphic programming software, enables users to easily take control and introduce students to the basics of software programming. "ASK NAO is a comprehensive solution designed to assist teachers with a range of fun and educational applications specially written to meet the needs of autistic children" (Humanoid robots, learning tools in the world of education, n.d.).

Utilizing NAO in a classroom setting promotes teamwork, problem-solving, project management, and communication skills as well as the ability to develop interdisciplinary projects. However, at a cost of over $9000.00, school districts may seek less expensive robotic solutions.

Arduino

Arduino, born at the Ivrea Interaction Design Institute in Ivrea, Italy, has inspired thousands of projects ranging from ordinary objects to complex scientific tools. Students, teachers, artists, professionals, and programmers have embraced this open-source platform. , Intended at students without a background in electronics and programming, Arduino as an easy tool for educational applications. All Arduino boards are completely open-source, easily adaptable and promote independent exploration by both teachers and students (Arduino - Introduction, n.d.).

Arduino provides an effortless user experience with software that can accommodate both the novice and advanced user and has been used in numerous projects and applications. It has been used by both teachers and students to build low-cost scientific implements, to prove chemistry and physics principles, and as the basis of robotics and programming. Arduino is a

popular tool for designers, architects, musicians, and artists, sparking creativity and the desire to learn new things (What is Arduino?, n.d.).

Arduino also simplifies the process of working with microcontrollers and offers some advantages for teachers, students, and interested amateurs over other systems. At a cost of less than $50 per board, Arduino is an affordable choice for many schools.

LEGO Education

For 35 years, it has been the mission of LEGO Education to work with teachers and education professionals to provide playful, impactful and fun learning experiences to classrooms around the world. "They have a wide range of physical and digital educational resources that encourage students to think creatively, reason systematically and release their potential to shape their future" (About us - LEGO Education, n.d.).

Their hands-on teaching and learning solutions inspire interest from science, technology, engineering, and math (STEM) to the humanities and language arts. Targeted at the preschool, elementary and middle school populations, close to 20,000 U.S. schools utilize LEGO Education solutions. Based on the LEGO system for playful learning, combined with curriculum-relevant material and digital resources, these solutions include lesson plans, educational sets, assessment tools, curriculum material, and teacher training and support. By providing teachers with the materials they need to make learning stimulating, engaging and effective, these tools support teachers in achieving their curriculum objectives.

With a belief in expanding knowledge and building 21st-century skills, with the help of educators, LEGO strives to enable every student to succeed in school and be prepared for the future as creative, dynamic, collaborative lifelong learners.

Their approach to learning was founded on a "4C" framework (connect, construct, contemplate and continue) through which "students are free to experiment and explore as they gain new knowledge," collaborate with their classmates and work through open-ended tasks facilitated and guided by their teachers (About us - LEGO education, n.d.).

Orbotix - Sphero

Created in 2010 by Colorado company Orbotix, Sphero is an affordable way to fuse robotics and digital technology into immersive entertainment experiences that ignite imagination and defy expectation. Optimized by data and powered by fun, these ever-evolving experiences are changing the way the world thinks about play (Sphero connected entertainment robots, n.d.).

Redefining play experiences became the company focus. In 2014, after years of meetup groups where we taught kids how to program, the SPRK education curriculum was launched. Sphero is currently incorporated into classrooms across the world with 7,000 participating schools, 20,000 teachers, and 300,000 students. While playing, SPRK exposes learners to STEM principles and the 21st-century skills of creativity, collaboration, critical thinking, and communication. Students are instantly engaged by witnessing the immediate reaction between their robot and the code. This allows students to reflect on their learning and "generate new ideas for what's possible between a program, a robot, the physical world, and their imagination" (Sphero breaks the rules with new SPRK bot - Yahoo Finance, n.d.).

Reasonably priced at $129.00 each or a class pack of 10 for $1200.00, Sphero can be easily incorporated into district STEM programs. With the new addition of the SPRK lightning lab, where students, teachers and makers can share their ideas and lesson plans, Sphero is one of the most innovative robotics platforms available (Sphero connected entertainment robots, n.d.).

Evollve - Ozobot

Ozobot, winner of the 2015 Kids at Play Interactive (KAPi) award for Best Robot, "is a smart robot that teaches kids how to code, engages them in deductive reasoning, and gives them a greater understanding of robotics overall" (Barba, 2015). Available in two models, the original ozobot can follow lines, detect colors, and can be programmed using visual color codes or can be programmed using the Ozogroove app. By merely drawing color-coded line patterns called "OzoCodes," OzoBot is programmed to associate specific movements with certain colors, allowing students to work on STEM/STREAM applications through hands-on robotics and programming applications.

The Ozobot Bit, which offers all of the functionality of the base Ozobot model, incorporates a block-based programming editor called OzoBlockly which affords students the ability to fully control its behavior. With Ozobot Bit, "students can make the natural progression from visual coding into the world of block-based programming" making this robot suitable from Kindergarten through high school (Ozobot teachers guide, n.d.).

The Ozobot is another affordable option for K-12 districts. A single Ozobot sells for $59.95 while a two-pack is available for $114.95. A classroom kit with 18 Ozobots and additional lessons and accessories can be purchased for $1200.00 (Empowering STEM education, n.d.).

Educational Technology has become a big business in the United States, and while schools are faced with a multitude of choices, they are "notoriously bad at picking ed tech that will actually help them teach" (Levy, 2016, p. 23). The area of robotics to promote STEM

education has seen some stiff competition in the last few years, and Bill Gates predicts that “the market for digital instruction materials will likely grow by $1.1 billion between 2015 and 2020 in the U.S. alone” (Molnar, 2016).

References

About Us - LEGO Education. (n.d.). Retrieved April 19, 2016, from https://education.lego.com/en-us/about-us

Arduino - Introduction. (n.d.). Retrieved from https://www.arduino.cc/en/Guide/Introduction

Barba, R. (2015, January 8). Top 5 kids educational robots at CES 2015. Retrieved April 18, 2016, from http://tech.co/top-5-kids-educational-robots-ces-2015-2015-01

Burke, A. (2016, April 19). Root is a robot teaching children to code. *Boston Globe*. Retrieved April 21, 2016, from http://www.bostonglobe.com/business/technology/2016/04/19/root-robot-teaching-children-code/IhfLDX90jvLpEB6yEJwZHJ/story.html

Empowering STEM education. (n.d.). Retrieved April 23, 2016, from http://ozobot.com/stem-education

Humanoid robots, learning tools in the world of education. (n.d.). Retrieved from https://www.aldebaran.com/en/solutions/education-research

International Association for the Evaluation of Educational Achievement. (2011). TIMSS 2011 international results in science. Boston, MA: TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College. Retrieved from http://timssandpirls.bc.edu/isc/publications.html

Levy, H. O. (2016). How should schools purchase technology for the classroom? *Education Week, 35*(27), 23.

Molnar, M. (2016, April 21). Bill Gates: Ed Tech has underachieved, but better days are ahead. Retrieved April 23, 2016, from https://marketbrief.edweek.org/marketplace-k-12/bill-gates/

NAO Robot - Professional Development for Teachers. (n.d.). Retrieved from http://www.teq.com/nao-robot

Ortiz, A. M., Bos, B., & Smith, S. (2015). The power of educational robotics as an integrated STEM learning experience in teacher preparation programs. *Journal of College Science Teaching, 44*(5), 42.

Ozobot teacher's guide. (n.d.). Retrieved from http://files.ozobot.com/stem-education/ozobot-teachers-guide.pdf

Resnick, M. (2007). Sowing the seeds for a more creative society. *Learning & Leading with Technology, 35*(4), 18.

Science and Technology. (2010). Prepare and inspire: K–12 science, technology, engineering, and math (STEM) education for America's future. Washington, DC: Executive Office of the President, PCAST.

Shannon, L. (2015). BEST robotics practices. *International Journal of Information and Education Technology, 5*(3), 179-183. doi:10.7763/IJIET.2015.V5.498

Sphero breaks the rules with new SPRK bot - Yahoo Finance. (n.d.). Retrieved from http://finance.yahoo.com/news/sphero-breaks-rules-sprk-bot-123000100.html

Sphero connected entertainment robots. (n.d.). Retrieved April 18, 2016, from http://www.sphero.com/education

Sullivan, F. R., & Moriarty, M. A. (2009). Robotics and discovery learning: Pedagogical beliefs, teacher practice, and technology integration. *Journal of Technology and Teacher Education, 17*(1), 109.

What is Arduino? (n.d.). Retrieved April 19, 2016, from https://www.arduino.cc/en/Guide/Introduction

Who is NAO? (n.d.). Retrieved April 18, 2016, from https://www.aldebaran.com/en/cool-robots/nao

Winters, M. (2015, December 21). Christmas bonus! US edtech sets record with $1.85 billion raised in 2015. Retrieved from https://www.edsurge.com/news/2015-12-21-christmas-bonus-us-edtech-sets-record-with-1-85-billion-raised-in-2015