Innovative Uses of Social Educational Robotics to Broaden Student Participation in STEAM Elena Novak¹ and Jong-Hoon Kim² **Educational Technology¹ and Computer Science²**

Abstract

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Educational robotics is a popular tool for introducing programming to novices. Although research on educational robotics is growing, most of studies used a version of LEGO robotics, which limits our understanding of how other types of robots can be used in education. This showcase presents several prototypes of custom-built educational social robots that were developed in the Advanced Telerobotics Research Lab at Kent State University and how these robots can be integrated into Science, Technology, Engineering, Art, and Mathematics (STEAM) education.

Current State of Educational Robotics

Educational robotics is a powerful and engaging tool for (a) introducing novices to computer science and computational thinking because of its ability to reify algorithms and programs, and (b) broadening participation in STEM (Angeli & Valanides, 2020). A recent review of research on educational robotics highlights the growing popularity of robotics in K-12 education and its ability to promote learning, creativity, motivation, and diversity in STEM (Anwar et al., 2019). Nevertheless, researchers and practitioners in educational robotics are concerned about the narrow presentation of robotics in education (Malinverni et al., 2021) because it is usually introduced as a technical field only, without considering its societal and ethical issues (Zawieska & Vermuelen, 2019). Moreover, K-12 robotics curricula usually focus on technical issues of assembly, construction, and operation of robots without connecting these ideas to mathematics and science (Chang & Chen, 2020). This narrow "technical" approach limits students' ability to develop an in-depth understanding of what robots can do for our society and inhibits their interest in robotics and computer science (Malinverni et al., 2021).

Computational Literacies and Educational Robotics

Traditionally, computational thinking was used as the umbrella for computing in K-12 education, focusing on skills and knowledge for college and career readiness. It is the "connective tissue" between computing and science, and computing and mathematics (Martin, 2018). It is the A recent revaluation of computational thinking in K-12 education (Kafai & Proctor, 2021) argues that the sociocultural dimension of computing should be considered we well, moving toward computational literacies. Computational literacies recognize that K-12 computing education may have multiple goals, e.g., preparation of new CS professionals, creativity expression, connecting with others, and social engagement. It views learning in terms of practice, identity, and participation (Sfard, 1998) using situated framings of computational thinking.

Computation Making and Robotics

The **computational making** framework was proposed to include additional skills promoted in maker-centered computational environments alongside computational thinking, such as aesthetics, creativity, constructing, visualizing multiple representation, and understanding materials (Rode et al., 2015). The framework allows for inclusion of Arts in STEM education. It was applied to learning with e-textiles and robotics.

Smart Robotic Puppet Theater

The Smart Robotic Puppet Theatre System (Kasibhatla et al., 2021) was created to engage performing arts students in Computational Thinking, Acting, and Making Education. It is a miniature robotic theater, made of customizable stages and puppet pieces, that may be used to create and present various puppet shows. The theater stage has a pan and tilt lighting system, audio integration through an external device, controlled curtains with stepper motors, props, and a grid stage. The light system's camera tracking module recognizes the presence of a robot and communicates with the light fixtures to angle the spotlight. The mBlock IDE is used to edit the story in the theater software, allowing for a straightforward method of scene programming. The puppet plays produced by the Smart Robotic Theater engage performing arts students in robotics and programming to build their own shows.



(A) Robotic Puppet Theater

GerminatorBot-19

GerminatorBot-19 robot was developed for fostering cooperation with COVID-19 health measures in college students and K-12 students. The robot can proactively interact with students in public areas such as school gates and cafeterias to provide sanitizing foam, check temperature, encourage students to wear a face mask, and conduct health check-ups upon demand. GerminatorBot-19 has five key features:

(1) Intelligent human-robot interaction: A smart interaction engine (SIE) enables natural conversation using natural language processing, computer vision, and machine learning technology.

(2) Virtual based Block Coding: A special virtual coding SIE module can be developed, so that the robot's interactions can be programmed and customized. (3) Mask wearing detection: The mask wearing detection algorithm can be integrated into the robot (Snyder et al., 2021). (4) Body temperature measuring: Low-cost, non-contact temperature detector can be designed and integrated with the robot (Alves et al., 2020). (5) Smart reward: An intelligent reward system can be designed for contactless reward points to-be-used as a promotional gift.

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(B) Visual Programming Tool for Scene Play Control



The Smart Trashcan was designed for teaching recycling to young children in an engaging way while introducing them to a range of computer science K-12 topics (2016). It integrates programming components that allow students to take control over a robot's behavior (Arnett et al., 2020; 2021). Open-source hardware was used to build this low-cost, yet functional and interactive mobile robot. The Trashcan's motions and gestures can be controlled via a visual programming interface (e.g., Scratch) that allows students and teachers to try out different methods programming methods. Trashcan uses vision recognition to identify recyclable objects and enters a dialogue with young children, educating them about recycling. However, its applications can be extended to teaching a variety of K-12 science topics including energy transformation and transfer, life science, and force and motion.



Low-cost Entry-level Educational Drone

Highly-accessible drone design and an accompanying education strategy, which, together, can alleviate the aforementioned problems. The major goals of the developed drone are to remain affordable as well as to enhance students' attention and motivation while maintaining a high level of functionality and safety. In the educational strategy, students will be divided into four different levels; each level will have its own procedure to enable educators to integrate robotics into existing curricula. At each level, moreover, students will learn increasingly more complex robotics subjects by interacting with the drone through a user-friendly visual coding interface





Smart Trashcan