

# Chapter 1

## Educational Robotics Theories and Practice: Tips for how to do it Right

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### ABSTRACT

*Educational robotics is a growing field with “the potential to significantly impact the nature of engineering and science education at all levels, from K-12 to graduate school” (Mataric, 2004, para. 1). It has become one of the most popular activities in K-12 settings in recent years. Educational robotics is a unique learning tool that creates a learning environment that attracts and keeps students interested and motivated with fun, hands-on, learning experiences. Many educators might ask; “What is educational robotics?” and “What does it do, and what is it for?” The purpose of this chapter is to present the foundation of educational robotics – from its background, pedagogical theories relating to educational robotics, learning experiences that educational robotics can provide, to tips for how to do it right. It aims to provide guidance on implementing educational robotics for K-12 educators in their educational settings.*

### INTRODUCTION

In January 2011, my college students and I brought our final projects from an undergraduate robotics course<sup>1</sup> to a local urban public elementary school in New Jersey. The purpose was to show the elementary school students what robots could do. There were about 45 fourth graders eagerly waiting for us in the gymnasium. As it turned out, none of the fourth graders had ever seen robots in person or LEGO Mindstorms NXT in action. That, in itself,

made our presentation very exciting. The students gathered around each robot, holding their breath as they waited to see the robot’s performance. The robot that excited the students the most was a pink Barbie-tank robot that followed a black line. It was about the size of a large shoebox. A line-following program made it follow a black tape circle on a large white paper. The students were amazed to see the robot following the black line. One of the students asked if it could follow a green line outlining the basketball court in the

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gymnasium. My initial reaction to the question was to doubt that the robot would follow the green line because the robot had been programmed to detect the specific reflection of black electric tape against a white surface. However, the student's question was so engaging and interesting that I replied, "Let's try it!" As I predicted, the robot did not follow the green line. The students were very disappointed. I explained that the program was set to follow a black line and the measurements for light reflected from the black and green were probably different. My explanation led to a new question from another student, "Can the robot follow a black line on the gym floor?" I predicted that the robot would probably not follow the black line because the brown color of the floor could be too close to black for the NXT light sensor to detect the difference. In the spirit of encouraging experimentations, I agreed to give their idea a try. The students were thrilled and excited. Luckily, we had a roll of black electric tape, with which the students made a long strip of a black line, from the stage all the way to the end of the gymnasium. Amazingly, the robot did start to follow the black tape. The students screamed with excitement and cheered the robot to keep going. They all lined up on the black line, making a tunnel with their legs spread apart. The robot went through their leg-tunnels all the way to the end, where it searched for the line by swinging in a circle until it found the line again and made its way back to the beginning. The students all applauded the robot, celebrating the joy of their new discovery.

A couple of weeks later, I received an envelope full of essays and drawings made by the students, each describing the robots that they dreamed of creating. Their ideas for innovative robots ranged from robots that do chores around house, including vacuuming, cooking and grocery shopping, to a car that drives by itself and a robot that helps students with their homework or teaches them in the classroom. Our robotics presentation had triggered their imaginations to think of creating robots of their own design.

About a decade ago, Hendler expressed his observation:

*A funny thing is happening in the field of robotics. A revolution is occurring without being noticed by many in the robotics research community. The robotics journals and conferences have largely missed the fact that robots are starting to leave the laboratory and make it out into the world. (Hendler, 2000, p.2)*

In recent years, robotics has become more visible in our everyday life. There is a robotic vacuum cleaner (<http://www.irobot.com/>) sweeping floors in our homes, even making sure that every corner is clean. In the field of medicine, robotics-assisted surgery is becoming so popular that some people even prefer to have an operation done by a robotic arm according to a New York Times article (Kolata, 2010, para. 10). The article reports that in 2009 "73,000 American men — 86 percent of the 85,000 who had prostate cancer surgery — had robot-assisted operations, according to the robot's maker, Intuitive Surgical, Inc." NASA uses the humanoid astronaut, Robonaut (<http://robonaut.jsc.nasa.gov/default.asp>) in the Space Shuttle Discovery's journey to the International Space Station. Meanwhile, military programs from around the world are sending more and more robots into war zones, according to ABI Research (Business Wire, 2011). In hospitals and offices, doctors and company CEOs are using mobile robots that they can access from a distance to communicate with their patients, clients and co-workers without them physically existing in the same space (Markoff, 2010).

Not only in our everyday life, but also in education, robots are playing an increasingly important role. Robotics is fascinating to the children "whose play will shape the future of the world" (Edwards, 2008, para. 2). The use of robotics in education has been growing in popularity (Berns, Braun, Hillenbrand, & Luksch, 2005; Carbonaro, Rex, & Chambers, 2004; Li, Chang, & Chen, 2009; Ma-

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