Chapter 17
Educational Robotics and Broadening Participation in STEM for Underrepresented Student Groups

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ABSTRACT

Engaging students in Science, Technology, Engineering, and Mathematics (STEM) is of particular interest to educators at all levels. Participation in these fields at the university level and beyond has decreased in recent years, and the issue is of particular interest in terms of the low representation of girls, minorities, and students with disabilities. This chapter will discuss the current state of research in the area of inclusive robotics at the pre-college level. In addition, strategies will be presented to help educators integrate robotics for diverse learners. Both pre-existing programs such as FIRST and self-developed activities will be discussed, including the selection of the robotics platform and programming software.

INTRODUCTION

The underrepresentation of women, minorities, and students with disabilities persists in STEM, particularly in computing, engineering, and physics. Significant factors in this under representation include lack of relevant precollege preparation role models, and limited access to resources. Other factors are societal in terms of stereotypes or the lack of a connection to the subject matter or how it can be applied to the betterment of society (Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development, 2000). Various approaches are used to reach out to the general precollege community when promoting Computer Science and other STEM disciplines as potential career paths. Examples include camps that last for a day or for weeks at a time, consisting of presentations about careers or skill building through activities such as programming in Alice, robotics, catapult building, or lab-based activities (Briggs, 2008; Cooper, Dann, Pausch, 2003; Marghitu, 2009; Marghitu, Ben Brahim, 2010; Sullivan,

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Cyr, Mooney, Reitsma, Shaw, Zarske, & Klenk, 2005). Some activities specifically target students within underrepresented groups while others are offered to the general public, such as those held at K12 institutions. Most participants in activities that target the general student population remain that of white males who are not disabled. Consequently, students from underrepresented groups do not have the same opportunity to learn about careers or acquire the precollege STEM skills that will help them successfully pursue STEM careers.

The use of robotics at the secondary school level has been made popular in part due to the availability of Lego Mindstorms. Interested students can further engage their interests by purchasing a consumer kit or by participating in a FIRST Lego League, Tech Challenge or Robotics Challenge team that may be offered at their school (FIRST, 2006b). Other competitions have also emerged such as BEST and RoboCup, the latter having tiers for pre-college and post-secondary competition (BEST, 2011; RoboCup, 2010). Additional robotics platforms can be leveraged for precollege students such as VEX and iRobot Create. Choices are abundant in terms of price points and programming language. Educators can choose to use a pre-existing program such as FIRST or to develop their own activities to correspond to specific course topics.

This chapter will discuss the current research in the use of robotics with underrepresented groups. In addition, an overview of options, strategies and resources will be presented in terms of providing equal access for all students.

BACKGROUND

As robot hardware and accompanying software have become less expensive and easier to use than their counterparts in industry and research, robotics has become more visible in K12 classrooms. Students design and program robots as part of science or technology courses. Robotics clubs have also appeared in many schools and in extracurricular organizations such as Girl Scouts. Either as program assessments, as partnerships between universities and school districts or as university-lead outreach activities (e.g. workshops and camps), research has been conducted in recent years in order to assess student achievement.

Several formal programs exist that provide an overall structure for experience across teams, including tournaments. A comparison of several popular programs is provided later in the chapter. In general, most programs (e.g. FIRST, RoboCup Junior, BotBall) have an annual game or set of challenges that are presented to teams during a season. Each team works together to design and program the robot to score the most points. Optionally, teams can register for tournaments to compete against other teams. While eligibility rules vary among the programs, students of all ages are eligible to participate in these types of programs. A teacher, or other adult, serves as the coach; mentors can also help guide students as they work together for a common goal. Programs such as FIRST and RoboCup have existed for years. Both the parent organizations and others have conducted research to assess the programs as a means of engaging students, including underrepresented students.

FIRST surveys participants and coaches annually. Historically, the high school level has been FIRST Robotics Challenge (FRC). A study has shown that overall participants in FRC are seven times more likely to go on to major in engineering than students who did not participate in FRC, 41% percent versus 6% respectively (Buckhaults, 2009). In addition, FRC alumni are twice as likely to major in computer science when compared to other students at 11% versus 5% respectively (Buckhaults, 2009). More in-depth research has been conducted in FIRST Lego League, which is geared to 9 to 14 year-olds. In this age group, the engagement in the material is of more interest since the students are years from attending college.