Chapter 18
DuBot:
An Open-Source, Low-Cost Robot for STEM and Educational Robotics

Avraam Chatzopoulos
https://orcid.org/0000-0002-2569-4147
University of West Attica, Greece

Michail Kalogiannakis
https://orcid.org/0000-0002-9124-2245
University of Crete, Greece

Stamatios Papadakis
https://orcid.org/0000-0003-3184-1147
University of Crete, Greece

Michail Papoutsidakis
University of West Attica, Greece

Dethe Elza
https://orcid.org/0000-0002-4422-5928
Richmond Public Library, Canada

Sarantos Psycharis
School of Pedagogical and Technological Education, Greece

ABSTRACT

This chapter presents the design and development of an open-source, low-cost robot for K12 students, suitable for use in educational robotics and science, technology, engineering, mathematics (STEM). The development of DuBot is a continuation of previous research and robot's innovation is based on three axes: (a) its specifications came from the 1st cycle of action research; (b) robot's visual programming language is integrated into the robot, taking advantage of the fact that it can be programmed from any device (smartphone, tablet, PC) with an internet connection and without the need to install any software or app; (c) is low-cost with no "exotic" parts robot than anyone can build with less than 50€. Furthermore, the robot's initial evaluation is presented -from distance due to emergency restrictions of Covid-19 is presented by the University of Crete, Department of Preschool Education's students.

DOI: 10.4018/978-1-7998-6717-3.ch018

INTRODUCTION

Today, we are experiencing the *4th Industrial Revolution (IR)*, that more and more academics, businessmen, politicians, and media outlets refer to (Marr, 2016, 2018), and directly affects the worldwide workforce as it requires workers with new skills (Chatzopoulos, Papoutsidakis, Kalogiannakis, Psycharis, & Papachristos, 2020). In this context, the *P21's Frameworks for 21st Century Learning*, a framework developed by the non-profit organization *"Battelle for Kids*" with input from teachers, education experts, and business leaders, suggests and defines the following skills and knowledge students need to succeed in work and life (Battelle for Kids, 2019):

1. creativity and innovation
2. critical thinking and problem-solving,
3. communication, and
4. collaboration,

STEM education and Educational Robotics appear to support (Papadakis, 2020; Psycharis, 2018) and prepare students for the 21st century and 4th IR requirements. STEM and Educational Robotics are increasingly considered as the newest trends in education (Zygouris et al., 2017), offering real practical experiences to the students, while hands-on robotic activities and tasks -due to their *play aspect*- are fun and attractive for them (Atmatzidou, Markelis, & Demetriadis, 2008; Papadakis & Kalogiannakis, 2020).

Robots and educational robotic platforms are the tools to apply Educational Robotics and STEM and can be considered an excellent vehicle for students to demonstrate fundamental engineering problems as they help them develop the above skills (Wagner, Hohmann, Gerecke, & Brenneke, 2004). To apply them in such a variety of subjects and different scenarios, these educational platforms have to meet several technical as well as educational requirements such as flexibility, modularity, scalability, ease of use (Wagner et al., 2004) and should be affordable enough, so that low-income students will not be excluded.

This paper describes the overall process of designing and developing an *Education Robotic Platform (ERP)* that aims to STEM education and Education Robotics activities for K12 students. This ERP's technical aspects and specifications did not come from the researchers' personal preferences, but the systematic data collection and analysis as they came from the 1st cycle of an Action Research.

Besides, this research's proposed robot innovates in a total of three axes:

1. Robot's specifications came from the 1st cycle of action research.
2. Robot's visual programming language is integrated into itself, taking advantage of being programmed from any device (smartphone, tablet, PC) with an Internet connection and without the need to install any software or app.
3. It is low-cost with no "exotic" parts robot than anyone can build with less than 50€.