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Application of Educational Robotics on an Automated Water Management System

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ABSTRACT

Early School Leaving (ESL) has a negative impact in the European educational systems. Despite the fact that ESL is a result of a long process of school failures, it seems that part of it has to do with specific educational practices. Furthermore, the latest studies show that the adoption of the educational Robotics (ER) could help regain the student's interest in school. In this article, the authors present a teaching approach using Educational Robotics. Within the RoboESL Erasmus project, that aims to encourage the weaker students to maintain a positive attitude towards school and at the same time promote creative thinking, teamwork and problem solving. The activity examines the optimization problem of the irrigation process by designing and implementing a fully automated system based on the Arduino Uno platform. Students are motivated to take responsibility for their own learning and understand how knowledge itself is constructed, while trying to find solutions to technical issues related to the irrigation problem. They are encouraged to try different approaches to learning and to take responsibility for their own educational progress.

KEYWORDS

6th Lab Center of Piraeus, Early School Leaving, Roboesl, Robotics Education, Vocational Education

1. INTRODUCTION

The problem of school failure and early school leaving (ESL) challenges European education systems and economies by influencing negatively personal, professional and economic growth. According to Eurostat, in 2013, approximately five and a half million young people in Europe did not complete upper secondary education and did not participate in any training program (Eurostat, 2013). Among the headline targets set in the Europe 2020 strategy is the reduction of the EU average rate of early school leaving to less than 10% by 2020. Early school leaving is a long process of school disengagement that culminates the first years of secondary school. Research studies show that drop-outs are students with low achievements or failure in one or more school subjects, very often in science, technology and math. However, many students failed in school or early school leavers identify the curriculum as discouraging factor towards staying at school. Educational content is boring or hard to grasp, activities are not related to real life and opportunities for hands-on activities are missing (European

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Parliament, 2011). Teaching practices are indicated as dry and far beyond students' needs. There have been voices in education world-wide arguing that there is a gap between the current educational practices in schools and the modern societal needs calling for an education that will foster creativity and inventiveness (Alimisis, 2012). Students claim they are rarely offered with opportunities to develop their creativity, to work on hands-on activities and to learn practical skills useful in their life; they often feel disappointed when their school reality lacks practical tasks that might connect learning to real life and the needs of the job market.

During last decade studies assure that educational robotics (ER) can provide learning experiences that promote children's creative thinking, teamwork and problem-solving skills – these essential skills are necessary in the workplace of the 21st century (Alimisis, 2013). STEM education is an educational approach that integrates Science, Technology, Engineering and Mathematics. However, a transdisciplinary approach is needed to integrate STEM knowledge and skills. ER is an effective learning tool which promote STEM education and help students explore the relationship between technology and daily life (Eguchi, 2014). ER toolkits have prepared the ground for the popularity of robotics in young generation. However, there is no systematic introduction of robotics in school curricula in European school systems. In addition to this, very often robotics is introduced as suitable only for talented science and technology majors.

RoboEsl project aims to exploit the potential of ER in order to tackle the ESL problem. The results from the first phase of the project in the 6th Lab Center of Piraeus, were very encouraging and the students came up with a proposal of a new "project" related to the optimization of the irrigation procedure. Their motivation was the environmental impact caused to the ineffective irrigation practices. They tried to design an automated system based on Arduino Uno platform. This procedure gave the professors the opportunity to design and run with their students, an extracurricular activity within the RoboESL project.

The paper is organized as follows: Section 2 presents the educational approach, Section 3 describes how the proposed educational activity was implemented in the 6th Lab Center of Piraeus. Finally, Section 4 concludes the paper and presents the general outcomes.

2. EDUCATIONAL APPROACH

The present curriculum proposal constitutes an application of Robotics within the context of education. It utilizes contemporary theories of learning (constructivism, project-based learning) with a student-centered approach (Paper & Harel, 1991). It examines the genuine issue of the effective administration of water resources, by provoking the student to design and implement an automated configuration for the collection and distribution of water through the use of the Arduino Uno programing platform. The students are encouraged to find solutions in various original, technical and programming related problems that arise during the educational process.

Our learning proposal was designed to meet the constructivism approach by learning under a collaborative context. Our activity aims to program and construct a water management irrigation system. The fundamental operations of the device are: a) the automatic replenishment of water in the water tank and the observation of the water level, and b) the control of the water distribution from the water tank. The main challenges are the control of the water tank in order to avoid an overflow as well as the nocturnal distribution of the water. The learning proposal is organized into 5 stages according to the project-based learning.

After completing the activity, the students will be able to:

- Identify the basic components of an automated system (technology)
- Design and construct a mechanism for the storage and distribution of water for irrigation purposes, by choosing the relevant elements (sensors, motors, water tank.) (technology)