Robotics and Programming Integration as Cognitive-Learning Tools

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INTRODUCTION

The technological improvements within the robotics field and its expansion to various fields such as medicine, industry and education, calls for robotics integration within the educational practice as learning tools. Alimisis (2012) supports that robotics draw the attention and interest of academicians, researchers and teachers in all educational levels as well as other stakeholders (policy makers and society leaders). Educational systems are responsible in preparing students (future citizens) for this ever-changing Hi-Tech, globalized, interconnected world. Numerous 21st century skills are reported in the literature as important to be developed by future citizens as the means to address the needs and demands of the society. Digital literacy is one of them and robotics and programing are becoming important elements within the educational settings. The students need to be provided with the opportunities to experience tinkering, fabrication, design and create technological artifact & interactive objects, construct their own meaningful projects, experience the scientific method of inquiry (Bers, 2008a; Bers, 2008b; Bers, Matas & Libman, 2013; Bernstein, Mutch-Jones, Cassidy, Hamner, & Cross, 2016; Eteokleous, 2016). Consequently, educators need to design learning environments enhanced by new technologies where students have the opportunity to experience them as cognitive-learning tools within their learning processes. In order for robotics to be integrated within the educational practice, teachers need to be appropriately and adequately prepared by universities (for pre-service teachers at the undergraduate level and in-service teaches at the graduate level) and professional development authorities (for in-service teachers) (Vollsted, Robinson, & Wang, 2007).

The current chapter takes into consideration numerous research studies suggesting that robotics integration for educational purposes is an effective teaching method; arguing that if robotics activities are appropriately designed and implemented have great potential to significantly improve and enhance the teaching and learning process (Bauerle, & Gallagher, 2003; Benitti, 2012; Bers, Flannery, Kazakoff, & Sullivan, 2014; Eteokleous, Demetriou, & Stylianou, 2013; Papert, 1993). Robotics in the classroom has taken a global momentum especially because of its positive contributions in the teaching of science, technology, engineering and mathematics (STEM) (Benitti, 2012; Bers, et al, 2014; Nugent, et al., 2009; Sullivan, 2008; Williams, Ma, Prejean, Lai, & Ford, 2007). Additionally, research has shown that robotics integration in education promotes the development of various non-cognitive skills, however extremely important life skills. For example, reasoning, problem solving, tinkerning, sequencing, computational thinking, decision making, scientific investigation, collaboration, knowledge construction, critical thinking, creativity, communication (Bers et al., 2002; Benitti, 2012; Bers, 2008a; Bers, et al., 2014; Chambers & Carbonaro, 2003; Eteokleous, 2015; Eteokleous, 2016; Miglino, Lund, &

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Cardaci, 1999; Resnick, Berg, & Eisenberg, 2000; Sullivan, 2008; Williams, et al., 2007; Williams, Ma, & Prejean, 2010).

Main Aim

Having in mind the above, the current study moves one-step further aiming to examine another aspect of educational robotics. The study focuses on robotics and programming as medium for developing cognitive skills in disciplines non-related to STEM. The purpose of the study is to examine how robotics and computer programming can be employed in the elementary classrooms (2^{nd} to 6^{th} grade) in order to achieve disciplinary learning objectives across disciplines (besides STEM). The following research questions guided the current study:

- In what degree did the disciplinary learning objectives are met? What did students learn when robotics and programming were used as cognitive-learning tools across disciplines?
- In what ways did teachers integrate robotics and programming across disciplines? What pedagogical and instructional approaches were employed by the teachers?
- What factors may influence robotics and programming integration as cognitive-learning tools in meeting disciplinary learning objectives?
- What were teachers' experiences, reflections, problems faced, and lessons learned from robotics and programing integration across disciplines?

BACKGROUND

Educational Robotics as a Cognitive - Learning Tool

It is suggested that there are two approaches related to robotics in education; 1) robotics as a subject matter and 2) integrating robotics as a tool within the educational practice to achieve specific learning objectives (Eteokleous, et al., 2013). The integration of robotics as a subject matter, as an autonomous entity, and not within a well-designed lesson plan, provide limited educational potential and value. On the other hand, robotics integration as a learning tool, in selected teaching cases exploits its full potential; therefore, it upgrades and enhances the teaching and learning process and promotes school transformation (Eteokleous, et al., 2013). The intention of this approach is not to learn how to use the robotics package, and its programming software, but to use it as a tool within a specific educational context to meet disciplinary learning objectives (Bers, 2010; Bers, et al., 2014; Bernstein, et al., 2016, Eguchi, 2007, Eteokleous, et al., 2013). In other words, robotics is employed as a tool to teach and deliver concepts within various disciplines such as Mathematics, Engineering, Science, Physics, and even in non-technology related fields such as Language and Linguistics, Arts, Biology, Psychology (Bers, Ponte, Juelich, Viera & Schenker, 2002; Eguchi, 2007, Eteokleous, et al., 2013). *Robotics integration* in the teaching and learning practice is defined as the use of robotics by students as a tool that enhances their learning experience and supports the achievement of specific learning objectives (Eteokleous, et al., 2013, Thomaz et al, 2009).

This approach is related to the *learning with* computers or computers as mindtools (Jonassen, 1999a), where computers and overall technology is introduced as students' partners within the teaching and learning process. *Learning with* technology requires integrating computers and overall technology as mindtools in the classrooms to support constructive learning. Educators embed technology capacity in the context of ongoing teaching and learning in different school subjects. Thus, students learn how to use technology not as an end in itself, but as a tool that help them execute their tasks and promote the balanced development of their mental abilities. As a result they do not learn from technology, but technologies support