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Behavioral patterns of elementary students and teachers in one-to-one robotics instruction

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ABSTRACT

Using robotics technologies in education is increasingly common and has the potential to impact students' learning. Educational robotics is a valuable tool for developing students' cognitive and social skills, and it has greatly attracted the interest of teachers and researchers alike, from pre-school to university. The purpose of this study is to understand the behavioral patterns of elementary students and teachers in one-to-one robotics instruction process. The participants were made up of 18 elementary school students and 18 preservice teachers. Quantitative content analysis and lag sequential analysis were used to analyze the student-teacher interactions. According to findings, the students' assembling bricks, sharing ideas and experiences, and the teachers' providing guidance and asking questions were the most frequent behaviors. Regarding behavioral sequences, the teachers' guidance significantly followed the students' behavior of expressing and sharing their ideas that followed the teachers' questions. The students also significantly tended to play with robots that they themselves designed. Moreover, the teacher-student interactions were discussed in detail in terms of gender differences and difficulty level of robotics activities. The results of this study can be taken into consideration in the design of learning environments with robotics activities.

1. Introduction

Developments in technology lead to new implementations in the field of education. Educational robotics (ER), considered as a technological application, is a valuable tool for developing students' cognitive and social skills and it has greatly attracted the interest of teachers and researchers alike, from pre-school to university, during the last two decades. This technology is used to support learning in schools, especially in the subjects of science, technology, engineering, mathematics and informatics (Bruciati, 2004; Kim, Kim, Yuan, Hill, Doshi, & Thai, 2015).

The field of robotics education has greatly evolved over the past two decades because of an increase of computing power and the improvement of types of sensor technology (Goh & Ali, 2014; Maxwell & Meeden, 2010). Mechanic construction, programming and creating algorithms for the program are basic elements in robotics. The learning of robotics requires a combination of these skills (Lin, Liu, Kou, Virnes, Sutinen, & Cheng, 2009). Programming can be considered complicated and difficult for students. However, Lego Robot is easy, and a fun way of programming which also enhances learners' motivation

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and the effectiveness of instruction in robotics education (Cheng, Huang, & Huang, 2013; Klassner & Anderson, 2003; Williams, 2003).

Lego robots contain a microprocessor, kind of body parts named Lego bricks, motors and sensors. The touch, sound, and light sensors allow interaction with their environments. Motors provide motions for the robot. A microprocessor is controlled by computer through the use of software. Logo programming language is used in these applications. These systems allow for easy assembly and programming. There are a variety of educational robotics kits (Lego Mindstorms, Robotis Dream etc.). Students construct various robots, by using robotics bricks. When they have completed the construction process, they can define their imagined tasks through programming (Bruciati, 2004; Dúill, 2010; Ozdogru, 2013). These hands-on activities are fun and attractive for students, thus, their levels of attention and curiosity remain high throughout the task. (Alimisis, 2013; Eguchi, 2010). Thanks to these activities, students can develop cognitive and social skills such as team work, problem solving, creativity, and robot design (Gerecke & Wagner, 2007; Lin et al., 2009).

1.1. Background of the study

Constructivism and constructionism are the main theories of behind educational robotics activities. Piaget and Papert's views are considered as a milestone in this field. According to them, children are not passive receivers in the learning process. On the contrary, they are active builders of their own knowledge. According to Piaget (1974), manipulating artifacts is essential for the construction of knowledge. Based on personal experience, knowledge is either constructed or reconstructed. Actively doing and thinking during a process provides a composition of concepts and rules, resulting in learning (Ackermann, 2001; Alimisis, 2013; Harel, 1991, pp. 24–27; Ucgul, 2013). In addition, Papert (1980) emphasizes the importance of a context in the knowledge of construction. Learners construct their knowledge as they consciously engage in a public entity such as a sand castle on the beach or a technological artifact. According to him, a technologically oriented educational system allows children to achieve for themselves the power to deal with whatever they may experience during the process of thinking and learning. Therefore, technological tools should be provided for children, in order to gain knowledge. The first studies of Logo in education extends to Papert (1980). Since this date, educational robotics studies have continued as an accepted significant topic (Benitti, 2012; Nugent, Bradley, Grandgenett, & Adamchuk, 2010; Somyurek, 2015).

When focused on learning by design, using robotics in education presents an effective environment for learning because it provides children with a learning environment in which children can interact with their surroundings and work through real life problems (Alimisis, 2013; Somyurek, 2015). While working with robotics, children also have active roles as designers and builders in such situations. During this learning process, they learn to investigate, create and solve problems through experiences (Goh & Ali, 2014). The robots are created with robotics pieces by children. There are either ready-written programs for the robots actions, or children can write their own programs while connecting robots to computer. As stated by Papert "Given a good programming language, I see children struggling to make a program work in a way that they seldom sweat at their paper-and-pencil mathematics" (Papert, 1999, p. 4). Therefore, for improving mathematics, as well as science, engineering, of technology skills of children, it is beneficial to design educational robotics activities. The elementary school ages are a crucial time for gaining these skills. Therefore, such programs should be instituted in suitable learning environments from preschool to university.

On the other hand, the new technologies can arouse and inspire learner's creativity. Also they can help students to become creative thinkers by suitable usage and design. Educational robotics can be a powerful tool for developing creativity because the robotics design process requires creative thinking. In this respect, it is important to design robotics learning environments which will support students' creative thinking. Therefore, in this study, a creative thinking spiral model proposed Resnick (2007) was used during the robotics instruction process (Lin et al., 2009). Indeed, this model was used in the kindergarten level for designing technological environments. However, it can be extended to learners of all levels for the support of creative thinking. This model includes five stages; imagine, play, share, reflect, and the next expended creative thinking spiral. Children *imagine* what they want to do, *create* a project based on their ideas, *play* with their creations, *share* their ideas and creations with others, *and reflect* on their experiences – all of which leads them to imagine new ideas and new projects During this process, learners develop and refine their abilities as creative thinkers and also learn to develop their own ideas, try them out, and generate new ideas based on their experiences (Resnick, 2007).

1.2. Robotics in education

Studies in literature report that using robotics technologies in education is increasingly common and has a potential impact on students' learning. Educational robotics kits are very helpful to teach the robotics and integrate robotics in other subjects. An educational robotics kit contains a micro-controller, various sensors, small plastic bricks, battery, cables, wheels, and gears. Thus, it is possible that building many kind of robots which able to detect objects and move without hitting any obstacle, carry objects through robot arms, detect sounds and walk to the source of sound, etc. Educational robotics kits usually focus kinematics, sensors, algorithm and coding, respectively. Therefore, they can be easily integrated to different subject areas such as informatics, mathematics, physics, engineering and more, and they are used at all education levels (Alimisis, 2013; Barker, Nugent, & Grandgenett, 2014; Benitti, 2012; Church, Ford, Perova, & Rogers, 2010; Eguchi, 2010; Williams, Igel, Poveda, Kapila, & Iskander, 2012).