Empirical Study of Psychological Impact on Students from Educational Robotics

Liang Gong[1,a,*], Zhuang Fu[1,b], Chengliang Liu[1,c], Peng Song[2,d]

[1]School of Mechanical Engineering, Shanghai Jiao Tong University, 800 Dongchuan Road, Shanghai, China

[2] College of Plant Science & Technology, Huazhong Agricultural University, No. 1 Shizishan Road, Wuhan, Hubei, China

[a]gongliang_mi@sjtu.edu.cn, [b]zfu@sjtu.edu.cn, [c]chlliu@sjtu.edu.cn, [d]songp@mail.hzau.edu.cn

*Corresponding author

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Abstract: Educational Robotics plays an important role in STEM (Science, Technology, Engineering and Mathematics) education and underpins a high-order labour education for future career development. Previously educators and engineers overlook the developmental and psychological implications of educational robotics, especially for students in elementary schools. The paper initiates an empirical study of the psychological impact side of the educational robots, highlighting the social and personal effects from a human-robot interaction perspective. First, a survey is designed to acquire the participants' social behaviour and their involvement in the educational robots. Second, a t-test based study of the social interaction, aggression, and reciprocal relationship are analysed quantitatively according to the questionnaires. The empirical study shows that students with education in robotics and those with no education in robotics differed in social interaction and aggression personality, however, it does not support the hypothesis that there was a difference in reciprocal relationship between the two original and control groups. This study reveals that the educational robotics has pros and cons with respect to their psychological reactions, which lays a foundation stone for stakeholders, such as educators, parents, and engineers are to take actions to avoid negative effects during whole-person education.

1. Introduction

Educational robotics has been popular in various educational settings in recent years, especially in STEM (Science, Technology, Engineering and Mathematics) learning [1,2]. Educational robotics teaches the programming, design, and application of robots, as well as physics, math, etc. Robotics has been taught to students at all levels, from elementary school to undergraduate programs [3,4]. The role of educational robotics is to serve as "programming project," which can be utilized in programming course to raise interest in programming see how coding can tackle real world problems. The second role for educational robotics is to stimulate interest in science, technology and artificial intelligence through integrative and interactive classes. Educational robotics also becomes "learning collaborator," in which robots with social capacities serve as companions [5]. Therefore, in addition to raise interest in STEM learning, educational robotics has been shown to be crucial in teaching social and personal skills. Educational robotics helps improve teamwork skills and communication skills, especially through building team-based projects in educational settings. The study of a complex engineering system also improves problem-solving skill that can be utilized in future careers [5].

However, in addition to the benefits of adopting educational robotics, educators and engineers must not overlook the developmental and psychological implications of educational robotics for children as a result of human-robot interaction. Educational robots are widely used with elementary school children. School-age children are developing social and personal skills. At the very stage of development, introducing educational robotics might impede development. For example, interaction with educational robotics might affect reduce social interest with human. In [6], they conducted interview with teachers in several focus groups and presented the concerns of educational robotics

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for children from teachers' perspectives. The study demonstrated that the major concern was that children might "prefer robots over human contact" in the presence of classroom robots and therefore reduce human interaction. Similarly, Sharkey [7] argued that classroom robots were likely to increase the risk of reduced social interaction with humans. The paper suggested that because robots were presented as convincing companion and peers, children were likely to form attachment to robots based on deception and thus increase the risk of reduced human interaction as a result.

Educational robotics might foster aggression in children. Because they do not see consequences of their behaviour, any abusive behaviour toward robots is likely to become more frequent and ultimately be carried over to human interaction [6]. When their abusive behaviour does not produce negative consequences, they are unlikely to learn the behaviour is bad. Therefore, aggressive behaviour with other children might be encouraged. Bartneck and Hu[8]'s study mimicked Stanley Milgram's obedience experiment on robots in college students. The study found that participants were more likely to abuse robots than other people. Similarly, Bršćić et al. [9] demonstrated that children showed obstructive behaviour toward robots.

On the other hand, children might develop asymmetrical power relationship with robots, in which robots might become like "butlers" that are subservient to children [6]. The study argued that children might develop an authoritarian attitude with robots. Children are likely to have difficulty in coping "with the natural give and take involved in playing with fellow students they might get used to being able to tell their robot companion what to do" [7].

Other than the form of social robots in classroom, the most common platform of educational robotics is robot kit operated on a software platform, such as LEGO® programmable robots. Based on the ethical concerns associated with classroom robots, the goal of this study was to investigate the developmental implications of educational robotics on school-age children. We administered questionnaires to children who had experience in learning LEGO® programmable robots and hypothesized that educational robotics would affect social interaction, aggression, and developing reciprocal relationship in children.

2. Method

2.1. Participants

A group of twenty students participated in the study. They were recruited from Jianke Robotics Studio in Pudong, Shanghai. The participants (age 6-10, 14 males, 6 females) were elementary school students (1st to 4th grade) who had been learning building LEGO® programmable robots by attending classes regularly (from 3 months to 12 months).

A group of twenty-two students were recruited from Baiyulan Elementary School in Pudong, Shanghai. The participants (age 6-10, 12 males, 10 females) were 1st to 4th grade students who had never been trained in building programmable robots in any form.

2.2. Design

Students who had access to building programmable robots were compared to the control group of students who had never learned building programmable robots. Questionnaires were administrated to both groups. The questionnaire measured three dimensions (social interaction, aggression, and reciprocal relationship) in both groups and compared the scores on each dimension between groups.

2.3. Material

A questionnaire was used to measure the variables that might be affected by exposure to educational robotics. The questionnaire measured three dimensions and consisted of 29 items: twelve items measured social interaction (social interest, social intention, experience sharing, and trust); eleven items measured aggression (physical aggression, verbal aggression, and anger); six items measured reciprocal relationship (reciprocity, asymmetrical power relationship). Items were rated on a 6-point Likert-scale ranging from 1 (strongly disagree) to 6 (strongly agree). Seven questions were reverse scored. The dimension, "aggression," was measured on an adapted version of the aggression questionnaire[10].

3. Results

Table 1 presents the scores of social interaction, aggression, and reciprocal relationship in children with education in robotics and children who had no access to education in robotics.

Table 1 Mean (SD) scores of social interaction, aggression, and reciprocal relationship in both groups.

	Social interaction	Aggression	Reciprocal relationship
Education in robotics	54 (10.61)	27.82 (7.84)	27.59 (3.07)
No education in robotics	46.15 (7.89)	34.20 (5.97)	31.3 (8.24)

An independent t-test was conducted for each independent variable to compare scores of children with education in robotics and children with no education in robotics. The independent t-test showed that children with education in robotics scored higher on social interaction than children with no education in robotics ($t(40)=2.7$, $p<.05$). Independent t-test also showed that children with education in robotics scored lower than the control group on aggression ($t(40)=-2.95$, $p<.05$). On the other hand, there was no significant difference in scores between two groups on reciprocal relationship. The result suggested that children with education in robotics and children with no education in robotics differed in social interaction and aggression, however, it did not support the hypothesis that there was a difference in reciprocal relationship between two groups.

4. Discussion

The present study investigated the impact of educational robotics on the development of children, and the questionnaire administered to children with experience in LEGO® programmable robots measured three dimensions (social interaction, aggression, and reciprocal relationship). We hypothesized that educational robotics would have influence on the three dimensions, and the results demonstrated that educational robotics would impede social interaction, increase aggression, however, we did not find evidence supporting the effect of robotics on the development of reciprocal relationship.

Educational robotics is a popular tool in STEM learning among school-age children. Research on the effect of educational robotics has raised concerns associated with using robots in classroom. However, there is a lack of research on the impact of utilizing robot kit such as LEGO® programmable robot on children. To fill in the gap, this study demonstrated that experience with educational robotics might lead to a few concerns, such as reducing social interaction and foster aggressive behaviour. Like social robots in classroom, experience with programmable robot students might also lead to detrimental effect on children.

The study suggested that experience with robot kit is likely to reduce social interaction with humans, such as parents and peers, by reducing children's social interest, trust in others, and willingness to share their experience. In addition, given the lack of consequences of children's behaviour toward robots, they are likely to engage in abusive behaviour without knowing. For example, they might break a robot's arm or pull off its leg. The abusive behaviour might be carried over to human interaction and thus encourage violence.

The implications for stakeholders, such as educators, parents, and engineers are to take actions to avoid negative effects. For example, parents might increase their interaction with children and help children learn the negative consequences associated with aggressive behaviour to robots. In designing robot user-interface, engineers must take into consideration the potential risks in human-robot interaction. For example, an alarm system might be utilized in robots when they are hit or punched in order to lessen abusive behaviour. Given the popularity of learning programmable robots, more attention should be paid to the impact of programmable robots on the development of students.

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