Evaluation of the ROOT Robot System and Curriculum to Improve Computational Thinking in Children

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Introduction

Children increasingly program computers. Computational Thinking (CT) is a fundamental skill to master, yet children often lack such skill. In this work, we contribute an analysis of the ROOT robot system and its associated curriculum to aid the development of CT skills in children aged 4-10 years old (in China). Results show 71% students developed “Excellent” CT performance and 29% achieved “Good” performance. ROOT aptly introduces CT through its curriculum, capable hardware, and cohesive software system.

Methodology

A. The ROOT robot system

The ROOT robot system consists of a cohesive environment between the mobile robot, its custom designed iOS app, and a well-designed scaffolded curriculum. ROOT is a 2-wheeled mobile robot equipped with a rich sensor. The IDE facilitates programming for children to adults: Graphical coding (ages 4+), Parameter coding (7+), and Full text coding (12+).

B. Participants

Two separate classes took place as part of an after-school program. A total of 15 children participated. Class 1 was comprised of 9 primary school students (7-10 years old). Five students had prior training in basic programming (i.e. Code Monkey), 4 students did not. Class 2 consisted of 6 primary school children (4-6.5 years old). These children had no prior programming skills.

C. Curriculum

Curriculum content was organized as part of a 10-12 week course. Each class lasted 1-1.5 hours per week. A typical class introduces equipment and module concepts, demonstrates coding functions, and lets students practice alongside teachers while completing tasks independently under a specified amount of time.

D. Evaluation and Measurement

Measured CT skills included: (a) Abstraction: solving abstract task; (b) Analysis: analyze results and correct mistakes; (c) Generalization: develop broad solutions; (d) Algorithmic thinking: step-by-step problem solving; and (e) Logical thinking: succeed in block order programming. To measure these, we employed likert-scale based questionnaires, think-aloud protocols, and pre-& post-tests.

Results

Children feedback indicated that Chinese children’s CT skills were improved 1 or 2 level through the ROOT system. According to students with Code Monkey background, educational robotics is a motivating tool to learn computational concepts compared with screen animations. Physical robots are intrinsically motivating creating an emotional connection between them and the children. On the whole, the average development of young students’(4-10 years old) CT skills are "Good" or "Excellent", their CT skills tend to developing in a positive direction when they learn programming with the ROOT system.