Fostering Computational Thinking and Collaboration Skills in Storytelling-based Primary Robot Programming Classes

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Abstract: This paper presents a course design and implementation of storytelling-based robot programming classes in a primary school. The course aims to foster computational thinking while students in 6th grade engaged in Ozo-bot programming activities. In addition, the class intended to promote students' collaborative problem solving skills as they create a story as a team for their robot to explore each theme of the story. To measure students' computational thinking skills the Bebras tasks are incorporated, and for collaboration skills a collaboration/communication questionnaire is administered. The current study reports the learning outcomes through the pre-post tests. In addition, this paper provides with the implications in integrating programming into creative storytelling contexts.

Keywords: Storytelling-based, Robots, Programming, Computational Thinking, Collaboration, Measurement, Instructional Intervention, Primary Education

INTRODUCTION

As working collaboratively with robots and peers is considered essential competency in near future, computational thinking(Wing, 2006) is widely recognized as the core competency. In Korea, various educational attempts are being made to foster students' computational thinking skills. Different instructional approaches are being incorporated with block-based programming(Scratch, Entry, App Inventor, etc.), educational robots(EV3, Wedo, Ozo-bot, Hamster, etc.), microcontrollers(Arduino, Lilypad, Microbit, etc.), extended hardware(Makey makey, Sensor Board, etc.), 3D printing, etc.

This study aimed to provide primary students with opportunities to express their ideas and stories incorporating with robots. It is claimed that computational thinking can be promoted by computer programming because it provides kids with solving problems applying their algorithms and debugging and troubleshooting while they solve the problems(Bers, 2018). Working with education robots can offer young kids to play with, observing how robots behave and debugging when errors occur. Along with computational thinking, solving problems with peers collaboratively is essential for kids to approach more difficult or complex problems.

This work-in-progress study reports an attempt to design and implement primary level robot classes in Korea. Specifically the study aimed to investigate how the new instructional intervention impacts on students' computational thinking and collaborative/communication skills.

CONTEXT & METHODOLOGY

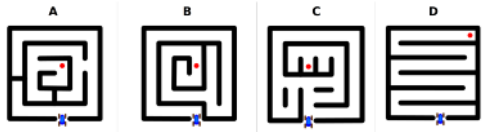
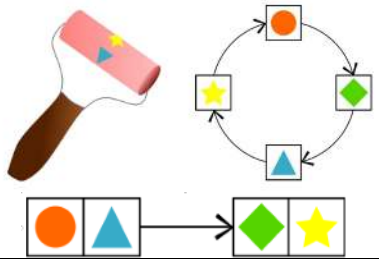
Participants and Research Procedure

Korean 6th graders participated in the storytelling-based robotics classes. Robots programming classes were designed in the software modules. The pre-CT Bebras tests and pre-tests of questionnaires were given before the first module and post-tests were given after the final module. 21 students participated in the pre-CT Bebras test and questionnaires. The current study is in progress and the post-CT Bebras test and questionnaries are expected to be completed.

Measuring Instruments

To investigate students' improvement of computational thinking skills Bebras items were incorporated. The Bebras tasks consisted of authentic problems used to measure students' computational thinking skills. In this study, three items were selected focusing students' algorithmic thinking skills(Table 1). The selected 3 items are from the Korean Bebras pilot test conducted in 2016 (Park & Jeong, 2017). In addition, to measure social skills we concentrated on collaboration and communication skills. Collaboration skills were measured using the 5-Likert scale by Yoon and Kim (2011). Communication skills were measured using communication the 5-Likert scale questionnaires by Choi and et al. (2013).

Table 1. Bebras items

Bebras Items
Maze : Maze Algorithm, Wall follower 
Painting : Computer vision, Image convert, Algorithm 
Neon text : Parallel processing, Programming 

Data Analysis

SPSS will be used for the data analysis. First, a matched pair t-test will be conducted to discover if robotics programming education improved students' computational thinking, collaboration, and communication skill.

Robotics Program Design

As Table 2 indicates, the robotics class including 6 modules was designed, and each module took 1 or 2 hours. The modules were designed to help 6th graders solve problems with real life stories. At first, students were introduced what software is and what kind of software is available. Then students engaged in an unplugged activity with command cards to understand how robot will understand human being commands. It followed with students' participation for them to create unplugged activities with poplar stories.

After the unplugged activity, students exposed to educational robot, Ozo-bot, for them to observe it and play with it. They became familiar with the robot and learned how it behaves. During this module students gained confidence on how to express their ideas with robots. In the next module students create a real-life story and express it with robots.(Figure 1~6)

For each module, students were urged to work together as a team of two acting one as a designer and the other as an engineer. The designer designs the robot and the engineer creates programs to solve the problems. The team members were encouraged to switch the roles back and forth allowing them to be able to perform two roles.

Table 2. Robotics class modules

Themes & Activities	**Hrs**
Introduce the meaning and kinds of software	1
Unplugged activity with command cards	2
Create unplugged activity with story and share with the class	2
Get to know Ozo-bot	2
Use Ozo-bot with various codes	2
Create Ozo-bot program from real-life story	2

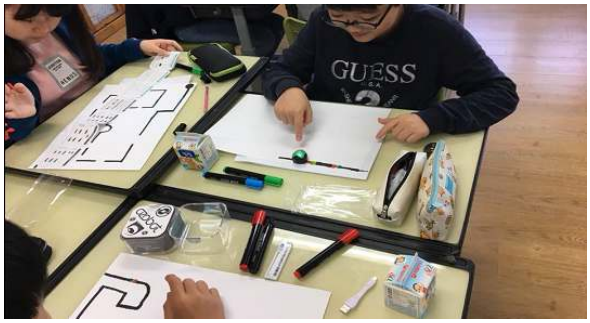


Figure 1. Getting Familiar with Robots

Figure 2. Getting Familiar with Robots working in teams

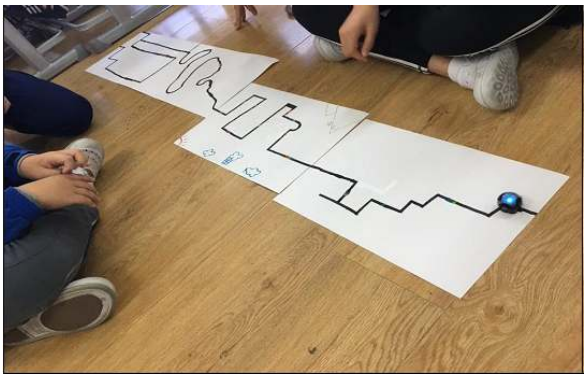


Figure 3. Collaborative activities

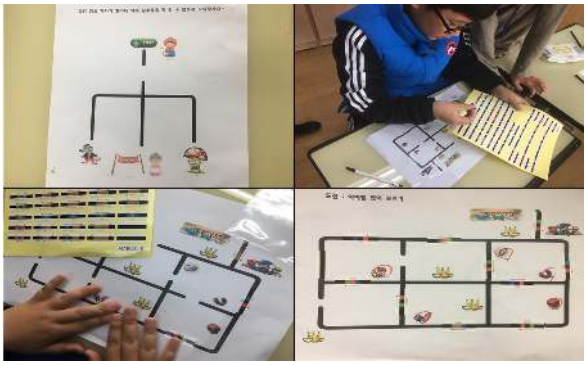


Figure 4. Learning how to tell stories with robots

Figure 5. Storytelling-based Robot Team Presentation 1

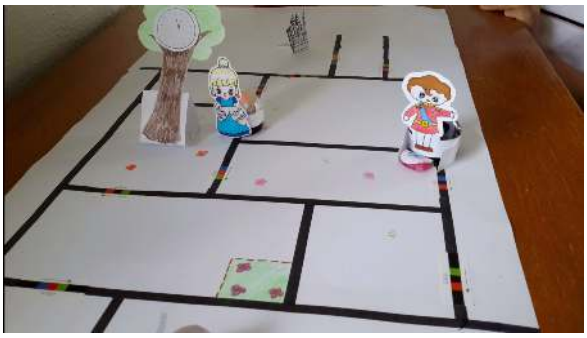


Figure 6. Storytelling-based Robot Team Presentation 2

RESULTS

Computational Thinking Skills and Collaboration Skills

At the time of this writing the post test is in-progress. Upon the completion of data collection, a paired samples t-test will be conducted. In addition, collaboration and communication skills post test is in-progress and the results will be presented at the conference.

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