ISSN 2010-3093

RESEARCH BRIEF SERIES

No. 19-026

Mathematical Learning Through Portable, Programmable Robots

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KEY IMPLICATIONS

- We developed an interactive, student-friendly and inexpensive robot that can move according to learner-determined kinematics graphs.
- Our research study demonstrated that the robots are an engaging and effective tool in helping students to visualize and understand abstract mathematical concepts like kinematics.

BACKGROUND

The traditional approach, where the educator transmits ideas, concepts and information to the learner, who is like a blank slate, can sometimes be problematic (Burns & Brooks, 1970). This is because most learners will simply discard their own thinking and fully subscribe to the teacher's answers and methods (Geist, 2010).

Based on the research team's past work, when learners are provided the opportunities to negotiate and discuss their intuitions about the phenomena/concept, they will have more enduring understandings of the concepts (Lim, 2015). Hence, this study proposes the use of robots in formal curriculum to provide students with an opportunity to experiment and learn through their own mistakes by resolving their misconceptions themselves.

FOCUS OF STUDY

This project aims to develop a robot that can provide physical and visual representations of graphs. These will provide students with an embodied understanding of kinematics, which results in better knowledge retention. The robot was trialed in a Secondary One Maths class to garner feedback from teachers and students about its effectiveness as a learning aid.

KEY FINDINGS

The project has developed a programmable robot, an accompanying user-interface and a lesson unit that utilises the robot as a learning aid. The robot is able to move according to a few different types of learner-determined speed-time and velocity-time graph, and allows for manual input of speed.

During the lesson trial, the students were observed to very engaged and enthusiastic to

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learn using the robot. The school teachers agreed that the robot was able to add more context to the abstract-mathematical concepts, helping the students to learn better while being more engaged.

SIGNIFICANCE OF FINDINGS

The lesson unit and robots serves as an effective and engaging substitution/supplement for traditional Kinematics lesson plans. This robot is relatively inexpensive and easy to use (compared to existing educational Robots like LEGO Mindstorms), allowing it to be easily adopted by any school.

The robots are made using relatively inexpensive yet functional electronic components (Micro:bit: and Herkulex smart servo) that can be applied to future educational projects that require robots.

PARTICIPANTS

There were a total of 40 students and three teachers from one school that was involved in the study. The students are all from Secondary One, around 13 years old and have little to no prior knowledge about Kinematic concepts.

RESEARCH DESIGN

This study is a development project that focused on the development of the robots, user interface and lesson unit based on the teacher's feedback and curriculum requirements.

The robot was trialed in a class of 40 Secondary One students. During the lesson, the team adopted participant-observer field-based approach to observe the student's mathematical learning. The study placed emphasis on: (1) whether the students showed signs of engagement; (2) whether they were independently experimenting; and (3) whether there were any issues regarding the robot or user interface.

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This brief was based on the project DEV 01/17 LYT: Mathematical learning through portable, programmable robots.

How to cite this publication

Lim, K. Y. T. (2018). *Mathematical Learning Through Portable, Programmable Robots*. (NIE Research Brief Series No. 19-026). Singapore: National Institute of Education.

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