Young Children Engineering Robots to Create Cities of the Future: A Work in Progress

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Abstract: This paper reports on a study pertaining to students at two elementary schools in Year 1 and Year 7 with the students using Lego robotics in their classrooms. More specifically the robotics is Lego's green city challenge as the students will be studying sustainability. Data for this study will be collected from a variety of sources including student artifacts and interviews. This research will add to the body of literature on teaching robotics and in developing pre-service teacher confidence in using and teaching robotics.

Introduction

Teaching robotics in the primary classroom is not a new concept. There is a great deal of literature regarding the value of robotics for student motivation (e.g., Brand, Coliver & Kasarda, 2008; Barker & Ansorge, 2007; Mauch, 2001; Nugent, Barker, Grandgenett & Adamchuk, 2010); and in the ways it enhances problem solving (e.g., Mosley & Klein, 2006; Norton, Ginns & McRobbie, 2007). There is also a variety of literature on its inclusion in the early years classrooms (e.g., Resnick, 1998; Bers, Ponte, Juielich, Viera, & Schenker, 2002; Kilderry, Yelland, Lazaridis & Dragicevic, 2003; Highfield, 2010); and for increasing specific subject matter knowledge (e.g., Chambers & Carbonaro, 2003; Lu, Kang, Huang, Black, 2011).

Robotics in the classroom has been proposed as a way to encourage students to undertake continued and further study in Science Technology Engineering and Mathematics (STEM) subjects, for example, as seen through teams of primary students participating in world-wide robotics championships and the advent of robotics clubs within and after school hours. Research studies reported in the literature, however, frequently make calls for further research in this field. Barker and Ansgorge (2006) for example, touted robotics as the next education tool, but provided little research to support this. Other authors have questioned the long-term sustainability of robotics in the classroom, noting that there can be a drift away from technology, particularly for girls (Rasinen, Vitanen, Endepohls-Ulpe, Ikonen, Ebach, & Stahl-von Zabern, 2009).

The proposed project is an attempt to influence young primary school students' learning so they will feel technology is a natural choice of tool for learning. At The University of Queensland the School of Information Technology and Electrical Engineering (ITEE) have had a decline in IT students and low intake of girls in technology programs. By introducing technology as a natural part of the learning in the elementary years of schooling, the young students may improve their logic reasoning and find a more positive attitude to studying technology when choosing tertiary studies. This project will provide an environment where staff from the School of ITEE and the School of Education can learn from each other and hopefully create better conditions for a more positive attitude to technology as a support for creative learning.

A key focus of this project is on the development of teacher confidence to embed the use of robotics in their classrooms so that robotics becomes an accepted aspect of the learning environment rather than an 'add on'. Predominantly, robotics is introduced in schools by one particular staff member, often by someone who has expertise in computer programming and who certainly has confidence to take on such a role. The eventual outcome is typically robotics challenges undertaken by the most dedicated students who work on their robots in their own time. The 'drift' away from robotics for the majority of students can be seen to occur here. This project will begin to fill the gap in the research literature regarding teacher professional knowledge of why and how to embed robotics to enhance the learning outcomes of all students in a continued way.

The use of robotics will be incorporated into a theme of sustainable living and embedded into the curriculum to promote students' understanding and awareness of the human-environmental relationship. This project deploys a series of design experiments within an action research framework, with project researchers developing robotics workshops together with classroom teachers and iteratively redesigning the workshops on the basis of feedback from students, observations, evaluations of learning outcomes, and collaborative team reflection. Robotics activities will be incorporated into the units and simple programming taught by a technology instructor. The teachers will learn robotics with the students. Pre-service teachers will also work with each class, thus enhancing their pedagogical technological knowledge.

Methodology

This project will work with teachers at two elementary schools at two specific year levels which are Year 1 and Year 7.

The aims of this project are to:

(a) Embed robotics into the primary school curriculum and create long term programs throughout the school that include all students.

(b) Improve student learning outcomes in motivation, engagement, problem solving, logic and the use of ICT.

(c) Improve teacher confidence in teaching robotics and using ICT in the classroom.

(d) Provide research in relation to teacher professional knowledge and the development of embedding robotics to enhance the learning outcomes of all students.

This study adopts both action research and design-based research methodology. Action research is typically undertaken by a team of concerned stakeholders in order to work together on an issue or problem within their environment. Action research methodology is a cycle of planning, acting, observing and reflecting upon actions implemented, followed by re-planning for the next cycle of actions in relation to the issue of concern (Kemmis and McTaggert, 2000). The collaborative nature of this project is well-suited to action research methodology as stakeholders include teachers, researchers, pre-service teachers and school administrators, as well as experts from the field of information technology and electrical engineering all working together to research student learning, teacher professional knowledge development, pre-service teacher education in relation to technology in the classroom. The main unit of intervention in this project is the robotics units, designed by the School of ITEE personnel (for technical support) together with teachers and education researchers (for pedagogical support and curriculum integrity). The development of units of work for the Year 1 and Year 7 classes will adopt a design-based research approach with its continuous cycle of design, enactment, analysis, and redesign (Design-Based Research Collective, 2003). The robotics units will be implemented by the Robotics Tutor with support from the classroom teacher and pre-service teachers.

Through this project, data will be generated in relation to four main themes: (1) student learning; (2) teacher technological, pedagogical and content knowledge; (3) essential ideas on sustainable futures and curriculum links across STEM subjects; and (4) pre-service teacher education and development. Through action research, a plethora of data are collected that will serve to assess these four themes. Student engagement and cognitive processes will be explored through observation, teacher questioning and in situ interviews with students. Year 7 student written reports via an iPad or a laptop will also be interrogated for this purpose. Student knowledge of environmental issues as a result of the robotics units will be assessed via student presentations, interviews and a pen and paper test for the Year 7 students and an oral version with simplified response formats for the Year 1 students.

A further thread running through this project will be students' development of spatial awareness and visual thinking, which will be assessed using pen and paper tests (Year 7) or oral version (Year 1) pre and post intervention. Matched control classes will also take these tests in order for comparisons to be made. The matched control classes will be Year 1 and Year 7 classes within the same school but not participating in this pilot project. Teacher technology knowledge will be measured through observation of degrees of confidence and interaction with the robotics sessions. Informal discussions through the project with teachers and the research team will provide illuminating information on the structures of support that are most beneficial to teachers in order for them to feel confident to implement robotics units with minimal or little assistance from the robotics tutor.

Each of the robotics units will be mapped against STEM learning outcomes, thus showing the curriculum reach of these units and the capacity of such units to integrate learning experiences. Analysis of student solutions and discussion on environmental issues will provide evidence of knowledge development in this field. Interrogation of pre-service teachers on their learning, and subsequent use of technology whilst they are on practicum will inform teacher education programs. Pre-service teacher confidence in using robotics technology will be determined through observation of their engagement during the robotics units.

The research questions that will guide this project are as follows:

- In what ways does the use of robotics in the classroom enhance problem solving and logic ability in students?
- How can ICT be used to enhance robotics learning?
- How is teacher confidence improved through the use of the robotics program in the school?

Data Sources

Data sources are varied and include a spatial awareness and visual thinking test. This pen and paper test will contain items in graphic form requiring students to interpret the visual information given in order to determine the solution to the question. Items for this test will be taken from published mathematics tests, such as the national numeracy test (as part of NAPLAN). The items will be age-appropriate for the cohort. It will take approximately 20 minutes for completion. Other data sources include:

Environment awareness test - This pen and paper test will comprise items, predominantly multiple choice, in relation to the focus of each robotics unit. Items will be devised by the classroom teachers, together with the researchers. The items will link to identified learning outcomes of STEM subjects.

Student artifacts - During the course of the units, students will use their iPads or laptops to reflect upon their learning, or to enhance the presentation of their final product. Other artifacts may include sketches of their problem solutions, or other notes they create during the robotics units.

Interview data - Informal and ad hoc interviews will be undertaken with students, teachers and pre-service teachers throughout this project. These interviews may be from audio or video file and will occur predominantly during the robotics sessions. These files will be scanned for evidence of advances in learning and thinking. This information will be combined with researcher observation notes throughout each robotics session.

Conclusion

This project will be conducted this year and will further add to the body of knowledge on teaching robotics with elementary school children using an integrated educational technology approach. This research project will also add to the pre-service teacher literature and their experiences using technology in the classroom.

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