The Experiences of Secondary School Students in Using Robotics to Transform E-Waste: Process and Products

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Abstract

In this study, secondary school students used robotics to transform e-waste into usable products. The Stanford Design Thinking Model was used to develop activities, appropriate for the ages of the students, for implementation outside of school hours. 28 volunteer students, divided into seven collaborative groups of four, participated in the 146 hour process. The students had developed the following by the end of the program: 'Smart Irrigation System,' 'Battery Meter,' 'Distance Meter,' 'Smart Walking Stick' 'Bluetooth Sound System,' 'Trash Can Sound System' and 'Smart Lamp.' These products were evaluated according to criteria specified in the literature. The data used in this evaluation are observations, video recordings, and the products themselves. Three-dimensional drawings, diagrams, and codes produced by the students were used to support the findings, and photographs of the products were also included. The design-focused thinking approach positively affected product performance, allowing students to both produce and test prototypes. All of the products developed are working systems. The Stanford Design Thinking Model provided a practical framework for the teaching of interdisciplinary and complex skills to secondary school students.

Keywords

Collaborative Learning, Design Thinking, Transformation of E-waste, Robotics.

INTRODUCTION

The growing global population and changes in consumer behavior are increasing the demand for electronic goods, and this, along with technological innovations and increased sales, is leading to the generation of millions of tons of e-waste [1]. E-waste, which refers to all electrical and electronic equipment that has reached the end of its useful life, is defective, or has been discarded by the user [2], is considered a serious environmental problem worldwide [3].

The harmful substances contained in e-waste, as well as the complexity of the recycling process, both pose serious threats to the environment. Furthermore, techniques such as uncontrolled incineration or landfilling used in the storage and disposal of e-waste, leads to the spread of toxic waste and air, water, and soil pollution. Furthermore, recycling the precious metals and rare earth elements found in e-waste, such as copper, silver, and gold, both present significant economic and environmental opportunities, as well as being critical for sustainable development [4].

One of the most effective long-term solutions to the problems of e-waste is to promote responsible use of electronic devices, avoid surplus consumption, recycle broken devices, and embrace a zero-waste approach. Accomplishing this requires an interdisciplinary approach to create innovation in education, while also leveraging the potential of robotics, a critical tool for a sustainable future [5].

In this study, the experiences of secondary school students in an out-of-school learning environment in which they transform e-waste into usable products using robotics are examined in terms of process and results. This 146-hour program was developed in accordance with the Stanford Design Thinking Model, and was implemented outside of school hours [6].

METHOD

A. Research design

As the aim of this study was to carefully examine a learning process comprised of out-of-school activities and the resulting products, a case study method and a qualitative research approach was chosen. This enabled a holistic approach to be followed through the combination of multiple data sources obtained throughout the process on both the dynamics of the process and the quality of the products.

B. Working Group

The ability to transform e-waste into products through the use of robotics requires certain cognitive and affective skills. This means that criterion sampling method is a suitable method of collecting targeted data from participants [7]. The criteria developed by the researchers covered basic computer literacy and interest in robotic activities. One of the researchers, based on previous observations at the secondary school where he worked as an IT teacher, invited students from the school who he believed met the study criteria. The environmental awareness of these students was assessed through face-to-face interviews,