EEGRC Poster: Improving Pre-service Elementary Teachers’ Nature of Engineering Views with the Use of EV3 Robotics

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Erdogan Kaya is a PhD student in science education at University of Nevada, Las Vegas. He is working as a graduate assistant and teaching science methods courses. Prior to beginning the PhD program, he received his MS degree in computer science and engineering. He coached robotics teams and was awarded several grants that promote Science, Technology, Engineering, and Mathematics (STEM). He has been volunteering in many education outreach programs including Science Fair and Robotics programs such as First Robotics competitions. Over the past four years, he published several journal papers and presented at national and international conferences. Areas of research interest include science and technology education, STEM, and robotics in science education.

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Anna Newley received a B.A. degree in Elementary Education from Arizona State University. She was an employee with the Tempe Elementary School District as a kindergarten, and second grade teacher, and instructional assistant until 2012. From 2012 to the current, she has been employed with the Sonoran Schools District. Presently, at Sonoran Science Academy-Phoenix, she is a fifth grade teacher. She is the contact for several grants awarded to the school. Mrs. Newley coaches the exploratory robotics club for grades 5-8, the Elementary Science Olympiad team, and the competitive high school robotics team, FTC. She contributed to international published papers, national proceedings, and is the process of writing several children’s books. This summer she will present a workshop on robotics for elementary school students.

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Hasan Deniz is an Associate Professor of Science Education at University of Nevada Las Vegas. He teaches undergraduate, masters, and doctoral level courses in science education program at University of Nevada Las Vegas. His research agenda includes epistemological beliefs in science and evolution education. He is recently engaged in professional development activities supported by several grants targeting to increase elementary teachers’ knowledge and skills to integrate science, language arts, and engineering education within the context of Next Generation Science Standards.

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Ezgi Yesilyurt is a PhD student in curriculum and instruction/science education at University of Nevada, Las Vegas. She is working as a graduate assistant and teaching science methods courses. She received her MS degree and BS degree in elementary science education. She participated European Union Projects in which she conducted series of professional development programs for in-service science teachers. Areas of research interest are engineering education, inquiry learning and evolution education.
Improving Pre-service Elementary Teachers’ Nature of Engineering Views with the Use of EV3 Robotics (EERGC Poster)

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ABSTRACT

The need for engineering educators K-12 students is an ever-present concern of makers of educational policy in the United States. With the release of Next Generation Science Standards (NGSS), engineering design is raised to the level of scientific inquiry. Both pre-service teachers and in-service teachers should be exposed to engineering design through professional development programs and modifications of existing science teacher education courses before they are asked to integrate engineering design to their science teaching. The aim of this paper is to document what extent pre-service identification of NOE aspects, confidence needed to integrate engineering into elementary science classes. Teachers have influence over the perceptions of their students; and although they have a powerful potential to sway students towards STEM careers, there is only some emphasis in engineering in middle and high school. Conversely, at the elementary level, engineering education is generally underestimated and neglected for the sake of other subjects. Additionally, there is extensive research about educational robotics in engineering education. However, there are few studies that address elementary school settings. For these reasons, we need more trained and well-equipped elementary educators that can teach engineering to their students. The purpose of this study is twofold. Our primary objective is to describe how we introduced engineering design into classroom through educational robotics kits. Pre-service teachers' NOE views were assessed at the beginning and at the end of the methods course to determine whether they improved their NOE views. NGSS aligned challenges with the Mindstorms EV3 educational robotics kit were used to explicitly teach pre-service elementary teachers about NOE. Because of the popularity of First Lego League (FLL) programs in engaging elementary students to engineering fields, researchers used materials associated with this successful program during the course.

POTENTIAL OF THE STUDY

We propose that with the help of EV3 robots, PSTs, with no experience in engineering concepts, can allow students to make more informed decisions about their career path. Robotics can trigger elementary students' interest in STEM careers and it can be a first step in the right direction to start developing engineering literacy.以前の研究では、進歩的科学的見解を考慮に入れたことを知る学生のパーソナリティが、大学でSTEM教育を受けた大学生への影響が示されました。この研究により、K-12の学生がSTEM教育や科学的理解が、より一般的な科学的見解であることを示しました。したがって、この研究はSTEM教育のパーソナリティに対する影響を検討することとした。

RESULTS

Eleven PSTs participated in this study. All participants were female, with an average age of 21 years, and with varying degrees of engineering knowledge. PSTs were enrolled in an elementary science teaching methods course offered at a university located in the southwestern United States during the Spring 2016 semester. We conducted this study within the context of an elementary science teaching methods course designed for PSTs. This course lasted for 15 weeks and included topics such as nature of science (NOS), students' misconceptions in science, concept mapping, teaching science through inquiry, 5-ES lesson planning, integrating science, engineering and language arts, technology applications in elementary science—engineering teaching, assessment, NOE, and NGSS. We spent three weeks on this unit and it allowed us to address three of the nine major topics that we covered in the course: (a) technology applications in elementary science-engineering teaching, (b) NOE, and (c) NGSS.

DATA COLLECTION

Data collected through an open-ended pre- and post-questionnaire designed to assess participants’ NOE views. We modified the Views of Nature of Science Version-C (VNOE) questionnaire to assess NOE views and we called this modified instrument the Views of Nature of Engineering (VNOE) questionnaire. Engineering notebooks, reflective essays, and student perceptions of their students; and although they have a powerful potential to sway students towards STEM careers, there is only some emphasis in engineering in middle and high school. Conversely, at the elementary level, engineering education is generally underestimated and neglected for the sake of other subjects. Additionally, there is extensive research about educational robotics in engineering education. However, there are few studies that address elementary school settings. For these reasons, we need more trained and well-equipped elementary educators that can teach engineering to their students. The purpose of this study is twofold. Our primary objective is to describe how we introduced engineering design into classroom through educational robotics kits. Pre-service teachers' NOE views were assessed at the beginning and at the end of the methods course to determine whether they improved their NOE views. NGSS aligned challenges with the Mindstorms EV3 educational robotics kit were used to explicitly teach pre-service elementary teachers about NOE. Because of the popularity of First Lego League (FLL) programs in engaging elementary students to engineering fields, researchers used materials associated with this successful program during the course.

CONCLUSION

We provided an account of how we introduced engineering design process into our elementary science teaching methods course, which was designed for PSTs. This research can be beneficial to science teacher educators who are planning to integrate engineering design into their elementary and/or secondary science teaching methods courses in an NGSS era. We explicitly introduced NOE aspects to PSTs and asked them to reflect on their engineering design experiences from the perspective of NOE aspects. As a result of our pre- and post-assessment of participants’ NOE views we found that they improved their NOE views. However, it is important to keep in mind that we only had 11 PSTs in our study and we used a modified version of an open-ended NOS questionnaire to assess our participants’ NOE views. Future studies should consider including more participants and using a more robust NOE questionnaire. Preparing PSTs to teach engineering design in elementary classrooms can be a first step in the right direction to start developing engineering literacy among elementary students. This increased awareness about engineering literacy can trigger elementary students’ interest in STEM careers and it can allow students to make more informed decisions about their career selections.

INTRODUCTION

To meet the demand for STEM teachers, the United States needs more focus on STEM teacher training to keep its leading role in the world. Since most high school students have already made career decisions by their senior year, and students are not fluent in their lessons, the focus of interest in engineering should start as early as elementary school to motivate students to consider a career in STEM. However, it is rare for elementary teachers to introduce engineering. Perhaps teachers do not have the confidence, or they are not well-equipped with knowledge and skills necessary to introduce engineering. Teachers' NOE views are targeted in this study. While the aspects of NOS are well established in pre college education, NOE aspects are yet to be considered by referring back to the reflections, all PSTs enjoyed coding and building robots.

ENGINEERING DESIGN PROCESS AND NATURE OF ENGINEERING

The Engineering Design Process (EDP) includes five steps: ask, imagine, plan, create, and improve (Figure 1). This cycle demonstrates that the EDP is not a linear, step-by-step method, but a never-concluding, dynamic process. It emphasizes that engineers ask questions, communicate with people concerning their needs, test ideas, revise and improve their designs, and share their solutions with the community. Engineers discuss, debate, arrive at the most feasible solution; they don’t work alone in an isolated cubicle. It is a creative and exciting process with a lot of human interaction. Everybody works together to constantly adjust their prototypes in order to solve problems.

These characteristics of the EDP are thoroughly described in the Nature of Engineering (NOE) views. Originally, authors were inspired by agreed-upon nature of science (NOS) aspects describe the relevant NOE aspects that are targeted in this study. While the aspects of NOE are well established in pre college education, NOE aspects are yet to be operationally defined as the greater emphasis on engineering in NOE views, nature of engineering (NOE) aspects are similar to NOS aspects except the aspect of the EDP.

Figure 1. EIE Engineering Design Process. Retrieved from www.eie.org/sites/default/files/downloads/EIE/edp_basic.png

Figure 2. Lego Mindstorms Robotics Kit. Retrieved from http://robotique.com/wp-content/uploads/2012/02/NTX-Education-979787a5.jpg

Figure 3. Nature of Engineering Aspects

Table 1. PSTs’ NOE Aspects Pre and Post Views.

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