Technological, Pedagogical, and Scientific Competencies Required for the Implementation of Robotics Activities in Science Education (Poster)

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Abstract

While the need for STEM (Science, Technology, Engineering, and Mathematics) workers is expected to continue to grow, there is a negative trend in the selection of these professions among students (NGSS Lead States, 2013). Robotics programs can be used to increase students' comfort levels with STEM applications, contribute to the development of engineering and computational thinking practices, 21st-century skills, and interest in STEM-related programs beyond high school (Ziaeefard et al., 2017). Nevertheless, due to a lack of competencies and low self-efficacy, many science teachers avoid incorporating technological accessories like robotics into their lessons and prefer to teach in traditional methods (Castro et al., 2018).

This research aims to identify the technological, pedagogical, and scientific competencies needed for integrating robotics activities into science education. Using a literature review in the field of robotics education and using previous work that identified competencies for teaching science, we defined a list of competencies required for integrating robotics activities into science education. In parallel with the literature review, experts and robotics experienced teachers interviewed on robotics and the competencies necessary for the development and implementation of robotics activities suitable for science education.

We identified the science teacher's competencies required for using robotics in science education, focused on different aspects of the TPACK model (Koehler & Mishra, 2008): (1) *Technological* competencies, e.g., base robot programming skills, and base robot building skills, (2) *Pedagogical* competencies, e.g., ability to analyze the activity sheets and to provide meaningful feedback, and ability to identify misconceptions, (3) *Content* competencies, e.g., content knowledge, practices, and strategies of scientists, (4) *Pedagogical* Content competencies, e.g., provide opportunities for students to conduct research on science topics in robotics environment, (5) *Technological Content* competencies, e.g., knowledge about using robotics for understanding and doing science, (6) *Technological Pedagogical* competencies, e.g., an understanding of where and when to use robotics in the classroom, and finally (7) *Technological Pedagogical, and Content* competencies, which includes ability to design appropriate robotics activities for science education.

Next, we plan to implement a science teacher development program and follow the development of the identified competencies through the learning activities during the development program. Also, we plan to examine science teachers' self-efficacy with respect to the identified competencies and examine how teachers' attitudes toward the integration of robotics activities in science education change as a result of their experience in the teachers' development program.

Keywords: Teaching Competencies, Science Education, Robotics, STEM, TPACK model.

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