Chapter 11
A Conceptual Framework for Educational Robotics Activities C4STEM:
A Virtual Educational Robotics Workshop

Georg Jäggle
https://orcid.org/0000-0002-4354-9787
TU Wien, Austria

Markus Vincze
TU Wien, Austria

ABSTRACT

This chapter investigates the development of a conceptual and methodological C4STEM framework to assess the learning outcome of educational robotics activities (ERAs) and demonstrates first case study on Virtual Educational Robotics Workshop. Several ERAs are challenges or competitions and are classified in navigational contests, duels, crusades, line follower, micro mouse, or climbing contest. These ERAs use different didactical strategies and methodological tools to teach students programming and CT. The C4STEM offers for a better comparison a template with a didactical approach to identify and share the best of ERAs with the community.

ORGANISATION BACKGROUND

TU Wien is Austria's largest scientific technical research and educational institution with eight faculties and about 30,000 students. Among them are 2.700 students in electrical engineering. TU Wien has a great pool of specialists who work on a wide range of different research topics through teaching and as partners of the industry. ACIN is one of 10 institutes in the Faculty of Electrical Engineering and Information Technology. The institute, headed by Prof. Andreas Kugi, is divided into the research areas of industrial automation and complex dynamical systems. TU WIEN-ACIN strongly emphasises close co-operation

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with industry, with 80% of the scientific employees being funded by national, European, and American industry or research projects. TU WIEN-ACIN conducts research in the areas of educational robotics, automation technology, control theory, machine vision, and cognitive robotics. Specific emphases of the research include educational robotics to lead young learners towards STEM careers, vision for robotics, and cognitive systems. The institute offers educational robotics workshops for classes from all schools. Our institute gathered experience with Educational Robotics Activities (ERA) through projects such as ER4STEM, iBridge, Makers@School and our outreach program. Approximately one thousand students participate in our ERA every year. The students are fostered in technological literacy, the 21st century skills and content knowledge about robotics technology. We evaluate them using a mixed methods approach with quantitative and qualitative methods.

INTRODUCTION

The European Commission (2020) reported that one of the aims of the agenda for improving the relevance of skills in the EU was to strengthen sustainable competitiveness by increasing the number of STEM graduates. Despite rising demand, the number of students completing a STEM programme is decreasing (Cedefop, 2014)

Caprile (2015) reported that the insufficient numbers of graduates arose due to negative perceptions of STEM occupations and identified two approaches for the education sphere. These approaches are developing effective and attractive STEM curricular and teaching methods and improving teacher education and professional development. This chapter shows an effective teaching method for attracting students to STEM fields and computational thinking. Educational Robotics is a valuable tool for practical learning of not only of robotics but also of STEM topics and computational thinking. Educational robotics activities (ERAs) increase interest in STEM but are mostly challenges or competitions classified as navigational contests, duels, crusades, line followers, micro mouse or climbing contests (Balogh, 2005) in the real world. These competitions take place at universities in out-of-school activities or are implemented in school curriculars. The situation with COVID-19 has denied students the option to participate in challenges and competitions face-to-face in the real world. A solution to this problem is to offer students ERAs online in a virtual world. However, this poses the problem that virtual worlds like "Second Life" and "Active Worlds" are, for the novice, a high-floor barrier. Therefore, we developed an online simulation workshop with a low-floor construction tool in a virtual world in a simulation robotics program with Thymio, an educational open-source robot. The workshop design is based on the C4STEM framework, which offers a standardized structure with activity plans and activity blocks. This chapter shows initial results regarding the influence of an educational robotics activity in a virtual workshop in increasing interest in STEM and robotics self-efficacy, collected in a case study. The virtual online workshop is based on the C4STEM framework, which offers comparable activities with an evaluation tool for robotics self-efficacy. The chapter provides a literature review of educational robotics and describe C4STEM in detail. The virtual educational robotics workshop was organized in two parts. The first part was comprised of three 4-hour sessions with two breaks. The second part took place one week later with two 2-hour sessions. Thirteen students participated on an online robotic simulation platform. Evaluation was based on mixed methods, with quantitative and qualitative results. The quantitative results were derived from an online survey with questionnaires before and after the online workshop. The qualitative results came from observations, tutor reflections and semi-structured interviews. The results