FOSTERING STUDENT TEACHERS' SPATIAL REASONING: THE ROBOTICS MARS CHALLENGE

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Spatial reasoning has been identified as a key element not only for learning mathematics, but also other fields related to science, engineering and technology (Gold, et al. 2018; Julià & Antolì, 20016, 2018). Research in this venue has identified some issues, including gender disparities in spatial reasoning abilities and their impact on the gender gap in STEM achievement (Lauer et al., 2019). These differences, however, can be reduced with targeted training (De Castell et al., 2019; Laurer et al., 2019). Such training can start at early years through robotics tasks (Francis et al., 2016; Francis et al., 2017). Teacher education program can be informed by such research results, increasing their focus on spatial reasoning and robotics.

Since 2014, the University of Calgary required all student teachers to complete the course STEM Education which has an emphasis on innovation and transdisciplinary (Preciado et al., 2016). The course involves robotics through exploration and design using Lego EV3 and WeDo kits. We conducted a preliminary study analyzing 20 student teachers' narratives, corresponding to a component of the course, with the purpose of identifying the elements of spatial reasoning involved in the task through the lens of the students.

The literature on spatial reasoning encompasses diverse perspectives including definitions of spatial reasoning (Davis et al., 2015; Ramful, et al. 2016; Zwartjes et al, 2019), spatial skills and spatial habits of mind (Kim & Bednarz, 2013), as well as the framework provided by Francis et al. (2017), developed from utterances of 19 experts in different fields on spatial thinking. We considered this variety of perspectives on spatial reasoning to conduct a deductive thematic analysis (Braun & Clarke, 2006) on the narratives from students' Mars Challenge robotic task (Francis et al., 2019) which requires students to work as a team to build and program a robot that moves different objects to designated areas.

Findings and discussion

From the students' narration on the Mar Challenge regarding the robotics tasks, seven significant aspects of spatial reasoning were identified: Visualization, 2D-3D reasoning, construction process, pattern recognitions, transformation (rotation), scaling, and the design process involved imagining. From this analysis, we can conclude that the task has potential to develop spatial reasoning skills for student teachers, with a potential impact on their future students. Such approach has also the potential to both reduce the gender disparities regarding spatial reasoning through the engagement in robotics tasks and address the need for more people to consider STEM career paths.

The narratives evidenced some impact of the course on student teachers' spatial reasoning in the Mars Robotics task. However, the sample size does not allow a generalization of the results to other students in the program. Therefore, there is a need for the development of a research design that addresses these limitations to explore the impact of the course on students' spatial abilities and describe their learning processes.

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