BUILDING A ROBOT: MAKING MATHEMATICS VISIBLE IN A NON-FORMAL STEM LEARNING ENVIRONMENT

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Emerging research has shown how student engagement with educational robots (e.g., Dash) can be associated with application and learning of mathematical concepts (e.g., Zhong & Xia, 2020). Yet, less is known about student learning in non-formal contexts (e.g., after-school programs) in contrast to formal learning environments (Pattison et al., 2016). The purpose of this proposal is to describe our varying, yet complementary analytical perspectives in understanding the complex nature of mathematical learning in a non-formal STEM environment. The project studied here – to design, build, and test an electronic vehicle – was not developed with an explicit mathematical goal(s) or objective(s). Thus, we intend to make the mathematical learning process visible through our emerging analytical perspective. Our proposed poster in the Theory and Research Methods strand will address a gap in the literature regarding how robotics can foster the application and learning of mathematics in a non-formal STEM learning environment (Karim et al., 2015), as well as address the PME-NA theme of looking across different cultures of mathematics and other disciplines (e.g., engineering). For context, data consisted of 24 days of audio/video recordings of two students, each equipped with a chest-mounted camera (i.e., GoPro) to capture their individual and collaborative points of view.

Our units of analysis are mathematical moments, or spontaneous experiences to engage with and explore mathematical concepts (Cunningham, 2015), that emerged as students collaborated in a non-formal STEM learning environment. To observe the growth of mathematical understanding in these moments, the Pirie-Kieren theory (1994) was used as an analytical tool. This theory perceives understanding as a dynamic, leveled but nonlinear, recursive process and describes eight levels of actions for mathematical understanding. By tracing the participants' growth of understanding along these potential levels, we can ascertain a global sense of the mathematical thinking and learning occurring during these moments. To complement the Pirie-Kieren theory and to capture details of the learning process, we apply additional frameworks to reveal perseverance pathways as the students navigated mathematical obstacles (DiNapoli, 2018) and their emotions as in-the-moment affective states (Middleton et al., 2017). We will detail our analysis of a mathematical moment through these three frameworks to make visible the learning that occurred in this non-formal STEM learning environment (e.g., the concept of variable through programming and engineering activity).

We argue that the overlay of multiple complementary perspectives on the same piece of data helps make visible the mathematics occurring in spaces where it may be hard to see otherwise, as well as provide triangulation of claims about student cognition and affect. This approach of aligning different views on an activity may be productive for other researchers as well. Ultimately, this work is a step towards understanding how non-formal environments can support mathematics learning and points of connection between non-formal and formal spaces.

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