

Forms of participation in an engineering maker-based inquiry in physics

Shulamit Kapon, Maayan Schvartzer, Tal Peer

Tweet: *Integrated STEM experiences present multiple learning opportunities through varied forms of legitimate peripheral participation.*

AUDIENCE: Curriculum developers; Formal educators

KEY POINTS

- Lessons that integrate the domains of STEM education are rewarding but see mixed results.
- Students engaged in two forms of participation: *participation as an engineer (PAE)* and *participation as a technician (PAT)*
- PAE facilitated the learning of physics content
- PAT fostered a sense of agency, but did little to facilitate science learning
- Well-designed STEM education can foster both agency and scientific understanding.

INTRODUCTION. STEM education as it has been criticized for the lack of integration between the different components of STEM, the lack of authenticity, and lack of opportunities for students to develop critical thinking, creativity, and soft skills. Studies have shown that while integrated STEM teaching does hold potential learning benefits, success is not guaranteed as it is dependent on many factors. This study followed two Israeli high school students as they designed, built, and tested a solar panel as part of their advanced physics studies. Over the course of 15 months researchers conducted observations of classes, interviews with students and their teachers, and analyzed student work samples. The goal of this study was to better understand how social constructs shape participation and learning in an integrated STEM learning experience.

FINDINGS. Students engaged in two forms of participation: *participating as an engineer* and *participating as a technician*. *Participating as an engineer* attends to the science and engineering practices of the project as students work to make use of scientific knowledge while attending to practical needs dictated by the project. *Participating as a technician* involves engaging with practical and functional aspects of the project without needing to

generate or understand scientific knowledge that drives the design process. Both forms of participation were viewed as valuable in by the learning community. Both forms of participation provided opportunities for different types of knowledge and skills to shine. While a student's *participation as a technician* can help develop a sense of agency and competence within the science classroom, it does not support the learning of science on its own. *Participation as an engineer* led to better learning of science content and practices. It is possible for students to engage in both forms of participation throughout a learning experience. Teacher-student discourse reinforced how students participated throughout the lesson.

TAKEAWAYS. Investing in the development of integrated STEM learning experiences may lead to more equitable learning opportunities. Allowing students legitimately engage with science and engineering through a technician role helps develop a sense of agency in students who may not have positive views towards STEM fields. This sense of agency may help develop a positive attitude towards STEM. It is important for teachers to push students to participate as engineers in addition to technicians so that they can reap the benefits of both learning experiences.