

# Making, Innovation, and Science Education: Considering Two Layers of Analysis

## Fresh Ontological Lenses Provide Novel Insights

Michael Tan

### KEY IMPLICATIONS

- Abductive reasoning underpins creativity, uniting the creation of new knowledge claims in science and creative efforts in other fields.
- Makerspaces can serve as community centres of innovation if attention is paid to setting up positive sociocultural factors underpinning knowledge creation.
- An ontology of science distinct from current perspectives may contribute to an appreciation of the nature of knowledge creation in science.

### BACKGROUND

Makerspaces are rapidly gaining attention in the local education community as sites for innovative STEM education. While this attention is welcomed in that renewed attention to STEM will inevitably lead to some positive changes, a concern exists that schools may “repackage old wine in new bottles”. Similarly, it is important to avoid fetishisation of technology, and work on the underlying sociocultural patterns of learning *prior* to amplifying these patterns with technology. This study then takes as givens that: technologies do not “plug-and-play” for learning; idiosyncratic goals within specific contexts have large influence on eventual learning goals; and learning is a multifaceted phenomenon requiring integration of studies on levels ranging

from cognition to sociology. The general approach here is to respond to the question of educative value of makerspaces: how exactly are makerspaces of value to learning in the Singapore context?

### FOCUS OF STUDY

With innovativeness as a focus, how do: (a) making activities in makerspaces, and (b) social organisation of makerspaces, contribute to student’s learning to be innovative individuals and organisations? For Study 1, an embodied cognition lens was used to interpret participants’ actions in creative problem-solving activity. For Study 2, a successful school-based makerspace was studied for cultural patterns of behaviour.

### KEY FINDINGS

The reasoning process underlying creativity appears to be abductive in nature: given a puzzling scenario in either the natural sciences or in creative problem solving, an initial abductive speculation needs to be made, and predictions arising from this speculation tested against reality. Through an iterative cycle, one gets progressively nearer to the truth or the creation of novelty. In controlled studies of participants’ problem solving, a greater degree of such speculation is correlated with better creative outcomes. As these speculations are

risky (they are often “wrong” in many possible ways), a sociocultural environment which welcomes and celebrates abductive sensemaking through cultural practices that defer judgment and encourages speculative experimentation is seen to be associated with an innovative culture that is accredited with awards in local and international comparisons. Underpinning this entire analysis is a revised ontology of science—an alternative understanding of *what science is*—attention should be paid not only to the standard representations of science, but also to its performative aspects. Just as knowing that the rotational inertia of a bicycle wheel contributes to its stability plays little part in knowing how to ride one, contemporary science is supported by a vast array of technological tools, the ensemble of which require much tacit knowledge to translate between it and textbook representations (and vice versa).

## SIGNIFICANCE OF FINDINGS

If innovativeness is perceived as central to Singapore education, it may be of much theoretical and practical interest to reconsider our approach to science instruction. Besides ensuring accuracy to canonical

forms, opportunities need to be given for students to generate new knowledge claims that require empirical investigation. Makerspaces, while loaded with things that often have prescribed means of interaction, should be configured for maximal flexibility for student driven inquiry instead. It is imperative that we relook the teaching, learning, and nature of science in school classrooms. Conventionally perceived, the successes of science and technology in everyday lives can obscure the uncertainty that is associated with knowledge production. If we continue to portray science as responsible for bringing us utopian visions of the future, we risk misrepresenting the tentativeness and the role of the humanities in imagining the future, to our own peril.

## POPULATION

Approximately 25 students and six adult volunteers from two schools were involved in this study.

## RESEARCH DESIGN

A video-based case study was used in the first part of the study. An ethnographic investigation was used in the second.

## About the author

Michael TAN is with the National Institute of Education, Singapore.

Contact Michael Tan at [michael.tan@nie.edu.sg](mailto:michael.tan@nie.edu.sg) for more information about the project.

This brief was based on the project OER12/14MT: Characterising Epistemic Engineering Practices in a School Makerspace.

## How to cite this publication

Tan, M. (2018). *Making, Innovation, and Science Education: Considering Two Layers of Analysis: Fresh Ontological Lenses Provide Novel Insights*. (NIE Research Brief Series No. 18-004). Singapore: National Institute of Education.

## Request for more details

Please approach the Office of Education Research, National Institute of Education, Singapore to obtain a copy of the final report.

>> More information about our research centres and publications can be found at: <http://www.nie.edu.sg>