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# The Singapore Young Physicists' Tournament Fosters Teachers' and Students' Orientation Towards the Practices of Science

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## KEY IMPLICATIONS

- Teacher instructional dispositions, epistemic positioning and improvisational skill were largely unchanged after professional development in formal workshop settings.
- The study of scientific problems of the Singapore Young Physicists' Tournament (SYPT) forces both the teacher and student to adopt an exploratory mindset so as to study the subject at the boundary of knowledge and ignorance.
- Opportunities for improvisational tinkering and computational thinking abound in SYPT problems and pose huge informal professional learning in the areas of Physics and Practices of Science.

## BACKGROUND

Improvisational Tinkering (MT) emphasizes the creative, improvisational nature of problem solving that is the hallmark of MT as an educative, inquiry-based practice in Science, Technology, Engineering and Mathematics (STEM) education. Broadly, MT refers to the skill involved in "making do" with limited resources: expert tinkerers are able to proceed when the rules "run out", and are also able to repurpose objects, ideas, and other resources to complete their design intentionalities. Computational Thinking (CT) refers to "the thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively carried out by an information-processing agent".

MT and CT align with the aspirations of the Singapore education system. The school Science curricula lists curiosity, creativity and perseverance, as some of the desired attitudes, and creative problem solving and communication as some of the skills that are highly desired.

## FOCUS OF STUDY

We followed a general principle guiding teacher professional development in MT and CT, namely (i) practice based; (ii) occur on a rapid iterative cycle; and (iii) offer participants multiple chances for reflective dialogue. For the first, initial group of participants, we created a run of formal experiential making workshops, where participants are expected to work through their way of using fabrication technologies to respond to the design challenge. For the second group of SYPT teachers and students, we deliberately eschewed formal workshop-style professional development. Instead, we participated actively as observers and advisors in guiding, discussing and reflecting together with teachers and students, how better to solve the SYPT problems they were tackling.

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## KEY FINDINGS

There are three key findings, namely (1) teacher instructional dispositions, teacher epistemic positioning within classroom interactions, teacher improvisational skill, and teacher skills in managing a different type of classroom interactions were unchanged after professional development in the formal workshop; (2) through active participation in a SYPT competition as teacher mentors, teachers' MT and CT skills improved; and (3) through being guided in the SYPT by teachers, there was significant learning by student participants about the boundaries of knowledge, the regimes of validity of theories taught in the classroom, and formulation and critiques of scientific arguments in a scientific discourse.

## SIGNIFICANCE OF FINDINGS

In conventional research in science education, it is assumed that there is at least an information asymmetry between instructor and student: instructors are in possession of some knowledge or skill which needs to be communicated to the student, who is in lack. Through our study, we conclude that a different, inquiry approach to the teaching and learning of science, through the study of scientific problems of the SYPT-type, i.e. open-ended, fuzzy, ill-defined, forces the instructor and student to adopt an exploratory mindset in which the instructor may possess more knowledge yet the knowledge-ignorance boundary may be unclear in the problem. Opportunities for improvisation (of experiments) to apply and test theories, for computation thinking in the design and implementation of workflows or algorithms to automate such computations, should be fairly liberal in the problem posed, in order that the greatest understanding of science, and of the Practices of Science, be achieved.

## PARTICIPANTS

A total of 4 MOE Secondary Schools and Junior Colleges, comprising 21 students and 25 teachers, participated in this study.

## RESEARCH DESIGN

This is a development project.

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