Research on Mathematical Investigation

Joseph Yeo B. W.

The purpose of this major research study on The Nature and Development of Processes in Mathematical Investigation is to examine the nature, interaction and development of cognitive and metacognitive processes in open mathematical investigation. Mathematical investigation is very important in many school mathematics curricula that emphasise problem solving and mathematical thinking because this is what real mathematics is: the type of mathematics that academic mathematicians do in their working lives, investigating and solving problems to discover new mathematics. Many researchers and educators believe that school students should also do some real mathematics, not the content at the level of the mathematicians but the processes that these mathematicians engage in, for example, specialisation, conjecturing, justification and generalisation. Thus it is vital to understand the nature and interaction of these processes and how they can be developed so that teachers are better informed to cultivate these processes in their students. Currently, there is a big research gap in this area of open mathematical investigation. Therefore, this research study can have a great impact on mathematics education.

The sample is 20 high-ability Secondary Two students from a top-end school who have no prior experience with open mathematical investigation. Phase I involves familiarising the students with the requirements of open investigative tasks during a two-hour lesson because a sub-study has revealed that most students will not know how and what to investigate. At the end of Phase I, each student will be videotaped while working on two open investigative tasks using the think-aloud methodology for the pretest. In Phase II, the students will undergo an intervention programme of five two-hour sessions of mathematical investigation where the researcher will try to develop certain processes in the students, for example, problem-posing strategies, problem-solving heuristics, the four main mathematical thinking processes of specialisation, conjecturing, justification and generalisation, and metacognitive processes to regulate their investigation behaviour. The investigative tasks in the posttest will be parallel to those from the pretest, except for an additional unfamiliar task which will be used to find out whether the processes learnt can be transferable to new situations.

The videotaped data collected during the pretest and posttest will be transcribed using a taxonomy of mathematical investigation behaviours which has been specially developed for this research study. The transcripts will then be analysed to inform the nature and interaction of the main cognitive processes in mathematical investigation which has been described theoretically using a model. The data will also be analysed to study the effect of metacognition on the students' choice of cognitive processes and their performance during mathematical investigation. Lastly, the effect of the intervention programme on the development of the students' cognitive and metacognitive processes, and on the students' performance, in mathematical investigation will be examined. The research study will end with some implications of key findings for mathematics education and directions for further research.