Abstract

This comparative study was conducted to investigate strategies and errors of Chinese and Singapore students at Primary 6 through Secondary 2 in solving speed problems at different difficulty levels.

A test comprising 14 speed problems was developed from a classification model and administered in group test in 2001. The classification model was developed to classify speed problems in mathematics textbooks from primary (Primary 3 for China, Primary 6 for Singapore) to Secondary 2 into six types according to the number of motions, number of objects involved, and the relative directions (same/different) of the motions described in the problems. Each type of problems was also subdivided in terms of given-unknown combinations and solution structures. The test was administered to 1002 Singapore students (Primary-6 345, Secondary-1 315, Secondary-2 342) from four primary and six secondary schools and 1070 Chinese students (Primary-6 361, Secondary-1 354, Secondary-2 355) from three primary and seven secondary schools in Wuhan City. The schools involved in this study were recommended by two officers. One had worked with Ministry of Education (Singapore) for ten years. The other had worked in Hubei Provincial Department of Education for five years. Students’ written responses were analyzed in three steps: (1) every response was scored with a 0-1-2 scale; (2) a strategy of every response was identified based on a problem-solving strategy model developed from literature review; and (3) an error category of every incorrect response was identified based on Fong’s (1993) schematic model. Also ANOVA and t-test were used to determine performance differences among different groups (nationality/grade) of students.
Four levels of speed problems were identified based on Item Location Parameters obtained from Rasch Analysis. The levels reflect the logic of the topic of speed. The performance differences between the Chinese students at the three grade levels were not statistically significant. However, the Primary-6 Singapore students performed statistically significantly better than the Secondary-1 and Secondary-2 Singapore students. The performance differences between the Secondary-1 and Secondary-2 Singapore students were not statistically significant. The Chinese students performed statistically and practically better than the Singapore students on three problems. The Singapore students performed statistically better than the Chinese students on one problem, but it has no practical effect size. The strategy analysis indicated that the Chinese students performed better than the Singapore students because they used algebraic strategies more frequently than the Singapore students, especially in solving problems at Levels 3 and 4. The Singapore students performed better than the Chinese students on Problem 7 because the Primary-6 Singapore students successfully used model drawing and unitary strategies. The Singapore students were found to use model drawing, unitary, guess-and-check, etc. more frequently than the Chinese students. However, the success rates of the use of these strategies were lower than those of the algebraic strategies that were used more frequently by the Chinese students. The error analysis indicated that the Singapore students made errors more frequently than the Chinese students, especially E3 (Incomplete schema with errors), E4 (Using irrelevant procedures) and E5 (No solution) errors in solving problems at Levels 3 and 4. Four possible reasons were proposed to account for these differences. They were: (a) the Chinese students might have been taught speed problems earlier and more frequently after the teaching of different mathematics topics as their applications to the real world; (b) the Chinese students might have been taught to use equations earlier and more frequently in solving word problems including speed problems; (c) the teaching of problem solving in Singapore might not reflect much on the use of various strategies (heuristics); and (d) the “testing-led” culture might also contribute to the Primary-6 Singapore students better performance than the secondary Singapore students.
For the students from both countries, the higher the performance level was, the more frequently they used algebraic methods, and the less likely they left the problem unanswered (no strategy). In addition, the Singapore students at high performance level used guess-and-check methods more frequently than the Singapore students at low and middle performance level. The Singapore students at high and middle performance levels used unitary methods more frequently than the Singapore students at low performance level. For the students from both countries, the students at the three performance levels made E1 (Complete schemata with errors) and E2 errors (Incomplete schemata with errors) in less than 6% of the cases. The higher the performance level was, the less likely they made E3, E4, and E5 types of errors.

The present study has some implications for the development of mathematics curriculum on the topic of speed, teaching and learning of speed, teaching and learning of algebra, teaching and learning of problem solving, and teaching and learning of ratio, rate and proportion in the two countries. It also recommends a number of areas for further investigations.