The Effects of Teachers’ Experience with SBI on Students’ Proportional and Mathematical Problem Solving Performance

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PURPOSE & FOCUS OF STUDY

This purpose of this study was to evaluate the effects of teachers’ experience with, and fidelity of implementation of, schema-based instruction (SBI), which has shown promise in prior work in enhancing students’ ability to solve problems involving ratio, proportion, and percent (e.g., Jitendra et al., 2009, 2011, 2013). We used a two-wave randomized cluster design, where teachers (clusters) were initially assigned at random to Cohort 1 or Cohort 2. During Wave 1 (AY 2012-13), Cohort 1 (n = 31) teachers taught the topics of ratio, proportion, and percent using SBI and their control group peers on a measure of proportional problem solving at posttest (γ = .46) and on a retention test (γ = .32). The current study examines data from Wave 2 and compares SBI-experienced teachers (Cohort 1) to SBI-novice teachers (Cohort 2).

RESEARCH QUESTIONS

What are the effects of teachers’ experience with, and fidelity of implementation of, SBI on seventh-grade students: (1) proportional problem solving performance immediately following the intervention, (2) retention of proportional problem solving skills 10 weeks later, (3) performance on a retention test, and (4) mathematics achievement?

PARTICIPANTS

The sample consisted of 73 seventh-grade mathematics teachers and their students from 48 public school districts in an upper Midwest state. Teachers’ mean years of experience teaching mathematics was 12.2 years (SD = 6.7, range 1 to 34 years). All teachers were certified to teach mathematics.

The final student sample included 1,845 students (834 in Cohort 1, and 1,011 in Cohort 2).

FIDELITY OF IMPLEMENTATION

SBI was implemented in treatment classrooms, five days a week for 45-50 min over 6 weeks. In the same time period, students in the control condition were taught the same topics (e.g., rates/proportion, scale drawing, percent) using instructional practices specified in their mathematics textbook. Within SBI, teachers used the following four instructional practices of (a) priming the mathematical structure of problems, (b) visually mapping information in the problem using schematic diagrams, (c) providing explicit instruction on a problem-solving heuristic, and (d) developing procedural flexibility.

<table>
<thead>
<tr>
<th>Problem Type</th>
<th>Example of Problem</th>
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<tbody>
<tr>
<td>Ratio</td>
<td>On Thursday, the cafeteria at Osseo Middle School sold: 42 smoothies, 75 main line lunches, 80 cookies, 51 bags of chips, 100 salad bar lunches, and 26 breakfast bars. What is the ratio of the number of main line lunches sold to the number of salad bar lunches sold on Thursday?</td>
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<tr>
<td>Percent: Part whole comparison</td>
<td>On a chapter test, Jane got a grade of 80%. The test had a total of 35 possible points. How many points did Jane earn on the test?</td>
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<tr>
<td>Percent of change</td>
<td>Mariah and Alex both started exercising more and each lost 8 pounds. Before they started exercising, Mariah weighed 160 lbs. and Alex weighed 200 lbs. Who had the greater percent decrease in weight, Mariah or Alex?</td>
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<tr>
<td>Proportion</td>
<td>The Frank family from Minnesota, USA, is going to Britain for their summer vacation. They exchanged $50 for 27 British pounds. At that exchange rate, how many British pounds could they get for $75?</td>
</tr>
<tr>
<td>Scale Drawing</td>
<td>On the map of the Disney World Theme Parks, a scale of 1 inch represents 3 miles. What is the actual distance between Magic Kingdom and Animal Kingdom when it is 4 inches on the map?</td>
</tr>
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MEASURES

Proportional Problem-Solving Test – 20 multiple-choice items and three short-answer conceptual items that assessed students’ knowledge of ratio, proportion, and percent. Reliability estimates for the PPS measure at pretest, posttest, and retention test were 0.75, 0.81, and 0.83, respectively.

Process and Applications Subtest of the Group Mathematics Assessment and Diagnostic Evaluation (GMADE) – 30 multiple-choice items measuring students’ comprehension of mathematical language and concepts and apply relevant operations to solve word problems across multiple content areas (e.g., algebra, geometry, number and operations). Pretest and posttest reliability estimates of the GMADE were 0.67 and 0.74, respectively.

Minnesota Comprehensive Assessment (MCA) Mathematics Subtest – state-administered standardized achievement consisting of 20 items across four strands, Number Sense & Operation, Algebra, Geometry & Measurement, and Data Analysis & Probability measuring students’ achievement in regard to the Minnesota Academic Standards.

RESULTS

Results of two-level (students nested within classrooms) hierarchical linear models indicated no statistically significant cohort differences on the PPS posttest (γ = .08, t(69) = .22, p = .82), PPS retention test (γ = .1, t(68) = .8, p = .97), the GMADE posttest (γ = .05, t(69) = .47, p = .64), or the MCA mathematics (γ = .45, t(66) = .61, p = .52) end of the year test indicating no differences between SBI-experienced and SBI-novice teachers on student outcomes.

CONCLUSIONS

This study further extends the literature on schema-based instruction by demonstrating that students of SBI-novice teachers performed equally well compared to students of SBI-experienced teachers. In addition, results indicated that SBI-novice teachers and SBI-experienced teachers implemented SBI with similar levels of fidelity. These results are encouraging as they suggest that teachers with limited exposure to, and experience with, SBI are able to implement it with the same level of fidelity as teachers with experience using SBI, and that students of SBI-novice teachers perform similar to those of SBI-experienced teachers.

ACKNOWLEDGEMENT

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