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Evaluating metacognitive scaffolding in guided invention activities.

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Summary: Invention and productive failure activities ask students to generate methods that capture the important properties of some given data (e.g., uncertainty) before being taught the expert solution. Invention and productive failure activities are a class of scientific inquiry activities in that students create, implement, and evaluate mathematical models based on data. Yet, lacking sufficient inquiry skills, students often do not actualize the full potential of these activities. We identified key invention strategies in which students often fail to engage: exploratory analysis, peer interaction, self-explanation, and evaluation. A classroom study with 134 students evaluated the effect of supporting these skills on the quality and outcomes of the invention process. Students in the unguided invention condition received conventional invention activities; students in the guided invention condition received complementary metacognitive scaffolding. Students were asked to invent methods for calculating uncertainties in best-fitting lines. Guided invention students invented methods that included more conceptual features and ranked the given datasets more accurately, although the quality of their mathematical expressions was not improved. At the process level, guided invention students revised their methods more frequently and had more and better instances of unprompted self-explanations even on components of the activity that were not supported by the metacognitive scaffolding. Classroom observations are used to demonstrate the effect of the scaffolding on students' learning behaviours. These results suggest that process guidance in the form of metacognitive scaffolding augments the inherent benefits of invention activities and can lead to gains at both domain and inquiry levels.

Classification: D45 K45 M55

Keywords: invention activities; productive failure; metacognitive scaffolding; inquiry learning; guided discovery

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