Measuring students' engagement and learning during problem-solving: the effects of problem-solving and reflective prompts

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Problem Solving

Positive Problem-Solving Behaviours:

• Orienting themselves with the problem
• Many strategies to select from – forming a plan
• Checking work/evaluating
• Knowledge-generation approach, not means-end approaches
Self-regulated learning (SRL) is learning that is guided by:

- motivation to learn.
- planning, monitoring, and evaluating progress against a standard (strategic action)
- metacognition (thinking about one's thinking)
Problem solving and Self-Regulated Learning

Reflecting, monitoring, controlling

- **Evaluate**: Monitor progress towards goals
- **Plan & execute**: Reflect on previous knowledge
- **Orientation**: Adjust approach; use reflections for future approaches
Goals:

Facilitate students to develop positive problem solving and reflective behaviours

....but, in order to support them effectively, we need to understand how students engage with problems, and then we can look at how our supports impact their engagement and learning
Research Questions:

1. How can students’ engagement while working on problems be characterized?

2. What are the effects of problem-solving and reflective prompts (scaffolds) on students’ engagement with problems?
• 300 students randomly split into three conditions: control, problem solving, reflective.
• There were no significant differences in prior knowledge of the students in the three conditions based on pre-intervention test scores (ANOVA, F(2, 298) = .016, p > .98).

Genetics Problem set:
5 questions

Prompt conditions:
Control
Problem Solving
Reflective
Devise a genetic explanation of these crosses. Show complete genotypes for the parents, the F1, and the F2.

- What are the ratios observed in the scenario?
- Draw a representation of the information given in the scenario.

- What do the ratios tell you about the problem?
- How did creating a representation of the problem help you solve the problem? Why did it help you solve the problem?
- What strategies did you use to help you successfully solve this problem that will be helpful to use for another, new problem?
1) How did students engage with the problem set?

Responses to the problem-set questions and the quiz were scored for:

- Correctness
- Quality of explanation
- Completeness → used to generate engagement profiles

<table>
<thead>
<tr>
<th>Scoring</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>Not attempted at all</td>
</tr>
<tr>
<td>1</td>
<td>Attempted at a basic level; not possible for raters to score correctness</td>
</tr>
<tr>
<td>2</td>
<td>Attempted and possible to score correctness</td>
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<tr>
<td>3</td>
<td>Completed question</td>
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1) How do students engage with problems?

**Engagement Profiles**

- **32%**: Run out of time
- **23%**: Pick-up
- **36%**: Sampler
- **9%**: Sampler
2) Does the type of prompt affect engagement?

Control: content & tasks, n=67

Problem Solving: strategies, n=113

Reflective: reflecting on strategies, n=120

\( \chi^2 (6, N = 300) = 185.59, p<0.01 \).
Conclusions

• Engagement with the learning activity varied significantly depending on scaffolds
  • Reflective prompts seem to be avoided.

• Measuring engagement with the learning activity is helpful to understand how we can support students’ development of positive problem solving and reflective behaviours.

• Prompt type had no significant effect on correctness or explanation quality on the quiz (MANCOVA, $p = .281$, $\eta^2 = .013$), but prior knowledge did have an effect ($p<0.01$).
Directions for future work and analysis

Within a single condition:
  • does engagement profile correlate with quality of work?
  • does engagement profile vary based on prior knowledge?

• Compare only those students who had a “complete” engagement profile – does condition effect correctness or quality of work.

• Longer time on the intervention: does increased engagement with reflective prompts affect learning and problem solving success?

• Foster a culture of engaging in reflective practices:
  • Often, in context, make it valuable, provide feedback
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Questions/ideas – please get in touch!
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