How Can Automated Feedback Engage Middle School Students in Developing Models?

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Background and Purpose

- Developing and using models can improve middle students’ understanding of complex scientific phenomena.
- Providing automated feedback during modeling activities has the potential to support students in rich scientific discourse while actively engaging in modeling practices.

Using video data from a larger NSF project (#1552114), this study aims to explore the following Research Question:

Research Question

How does automated feedback help 8th-grade pairs develop, revise, and explain scientific models to represent the relationship between thermal energy and molecular motion during a phase change?

Participants, Technology & Procedure

Participants

16 pairs of 8th-grade linguistically diverse students from a low-income middle school.

Procedure

Received pre-coded video data from a larger NSF project

Revision on an existing coding scheme and re-code some data

Qualitative analysis on students’ discourse patterns

Analysis Methods and Results

Analysis Methods

- Each pair was videotaped during the modeling activity.
- All 16 videos were fully transcribed, including verbal statements and interactions between students, as well as events on computer screen.
- Students’ talk turns and actions were coded using an existing coding scheme to understand how feedback affected their discourse and action patterns during the modeling activity.
- This study utilized already-coded transcripts and recoded them with adjusted coding scheme.

Sample Coding Scheme

<table>
<thead>
<tr>
<th>Major Codes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critique and Evaluation</td>
<td>Detailed analysis and assessment of partners’ idea or own ideas</td>
</tr>
<tr>
<td>Ask Questions</td>
<td>Raising questions and engaging in inquiry processes</td>
</tr>
<tr>
<td>Proposing and Explaining</td>
<td>Suggesting ideas or actions to build and explain models</td>
</tr>
<tr>
<td>Build and Explain Models</td>
<td>Using modeling tool to build model and rearrange the structure or generating scientific explanations</td>
</tr>
<tr>
<td>Use and Interpret Evidence</td>
<td>Sudden insight or understanding about an idea or feature of the tool based on feedback</td>
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The results showed that all pairs engaged in productive discourse by proposing ideas on how to build or revise their models, critiquing or evaluating their own or partner’s ideas, and asking questions while actively interacting with the modeling tool to build and revise models after receiving automated feedback.

Analysis

- ELF Group: Completing the models successfully ~ 7.6 feedbacks
- NEUF Group: On average completing the models successfully ~ 15.5 feedbacks

Categorize pairs into two subgroups:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Effective Use of Feedback (EUF) Group (10 pairs)</th>
<th>Less Effective Use of Feedback (LEUF) Group (6 pairs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus of Conversation</td>
<td>• Actively read aloud and interpreted both textual and visual feedback</td>
<td>• Passively received information and no interpretation</td>
</tr>
<tr>
<td></td>
<td>• Utilized feedback to raise questions</td>
<td>• Failed to integrate feedback content</td>
</tr>
<tr>
<td></td>
<td>• Proposed new ideas</td>
<td>• Failed to apply feedback to revise models</td>
</tr>
<tr>
<td></td>
<td>• Critiqued / evaluated work</td>
<td>• Spend long period arguing who is responsible for the low scores</td>
</tr>
<tr>
<td></td>
<td>• Revised models using feedback</td>
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</tbody>
</table>

Evidence

- More Scientific Discourse in ELF Group
- Build Models more Effectively in ELF Group

Student Discourse Example:

Computer: (providing automated feedback on a missing idea about molecular motion in Box C)  
Student2: [laughs] just say what I said, it went from no movement to-
Student2: It went from a minimum of movement  
Student2: To a fast/ to a fast expanded movement  
Student1: Yes Yes!

Conclusion

This study showed that although automated feedback is helpful for middle school students during a modeling activity, students had different discourse and action patterns when interpreting feedback differently.
- Students who used feedback effectively build the models often show characteristics of actively read and interpret feedback information
- Students who used feedback effectively engaged in more scientific discourse and meaningful revisions of models than students who used feedback less effectively.