

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.

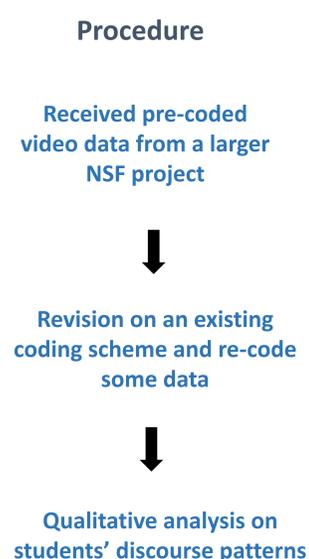
Using video data from a larger NSF project (#1552114), this study aims to explore the following Research Question:

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?

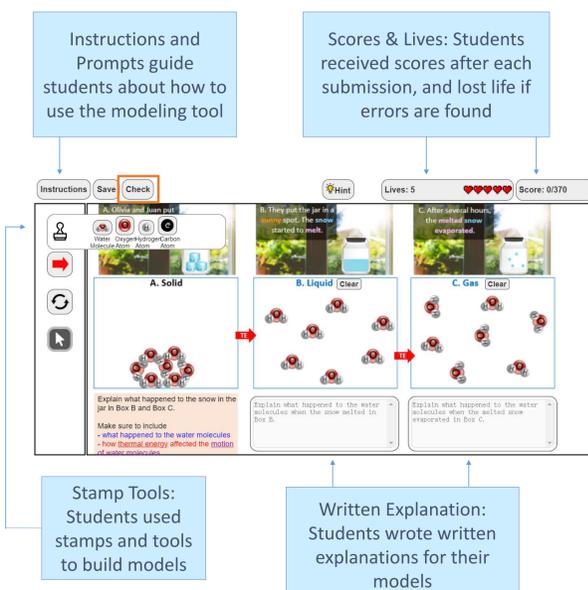
Participants, Technology & Procedure

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

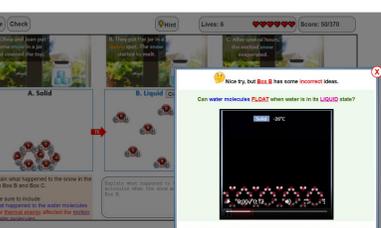


Properties of Matter (POM) Modeling Tool

During inquiry instruction, pairs used a Properties of Matter (POM) modeling tool to build and explain visual models to represent how thermal energy affects the motion and spacing of water molecules during a phase change.



Students used POM Modeling Tool in pairs



Screenshot of Automated Feedback

Pairs were able to submit their work to receive automated feedback based on the target concepts and misconceptions represented in their models and explanations.

Analysis Methods and Results

Analysis Methods

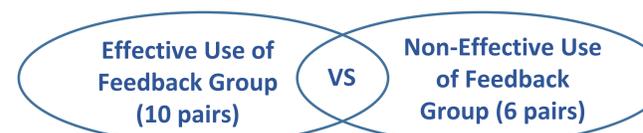
- Each pair was **videotaped** during the modeling activity.
- All 16 videos were **fully transcribed**, including verbal statements and interactions between students, as well as events on computer screen.
- Students' **talk turns and actions** were **coded** using an existing coding scheme to understand 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

Major Codes	Description
Critique and Evaluation	Detailed analysis and assessment of partners' idea or own ideas
Ask Questions	Raising questions and engaging in inquiry processes
Proposing and Explaining	Suggesting ideas or actions to build and explain models
Build and Explain Models	Using modeling tool to build model and rearrange the structure or generating scientific explanations
Use and Interpret Evidence	Sudden insight or understanding about an idea or feature of the tool based on feedback

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.

→ Categorize pairs into two subgroups:

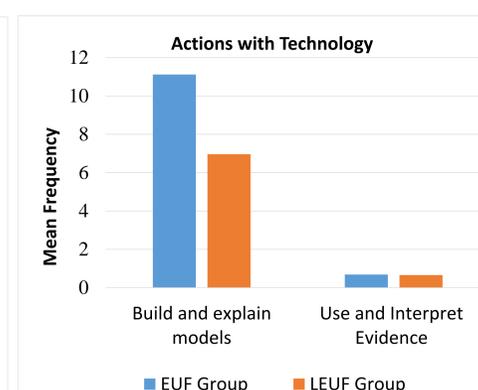
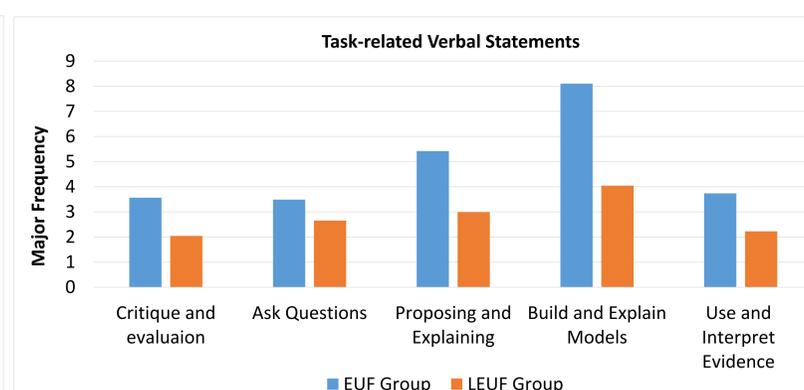
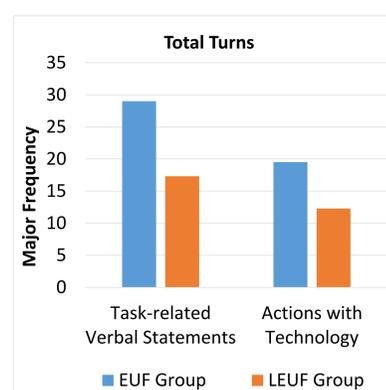


EUF Group: Completing the models successfully ~ 7.6 feedbacks

NEUF Group: On average completing the models successfully ~ 15.5 feedbacks

	EUF Group	NEUF Group
Mean	7.6	15.5
SD	2.80	4.09

Characteristics	Effective Use of Feedback (EUF) Group	Less-Effective Use of Feedback (LEUF) Group
After Receiving First Feedback	<ul style="list-style-type: none"> • Actively read aloud and interpreted both textual and visual feedback 	<ul style="list-style-type: none"> • Passively received information and no interpretation
Focus of Conversation	<ul style="list-style-type: none"> • Utilized feedback to raise questions • Proposed new ideas • Critiqued / evaluated work • Revised models using feedback 	<ul style="list-style-type: none"> • Failed to integrate feedback content • Failed to apply feedback to revise models • Spend long period arguing who is responsible for the low scores



More Scientific Discourse in EUF Group

- Students engaged in more scientific discourse such as critique, proposing ideas, and asking questions

Build Models more Effectively in EUF Group

- Students engaged in modeling activities more effectively rather than ineffective revisions

Student Discourse Example:

Computer: ((providing automated feedback on a missing idea about molecular motion in Box C))
 Student2: noooooo //ok, almost there! you are missing some information in box c ((exit feedback))
 Student1: //(laughs) just say what I said, it went from no movement to-
 Student2: It went from a minimum of movement
 Student1: to a fast- //to a fast
 Student2: //to a fast and- and 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 to successfully 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.