A Natural Language Processing (NLP) Driven Teacher Dashboard to Support Responsive Instruction

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Research Questions

How do teachers use a dashboard, the Teacher Action Planner (TAP), featuring NLP analysis of student work?

What responses do teachers make to the TAP analysis of student work based on Knowledge Integration (KI) pedagogy?

A Research Practice Partnership developed the TAP showing students' evolving understanding in inquiry science. We study how 8 pre-college science teachers used the TAP in remote instruction using interviews, classroom observations via Zoom, and logged student data.

Knowledge Integration Design

Unit, embedded assessment, and dashboard design follow **Knowledge Integration (KI)** pedagogy: **Elicit** student ideas, guide students to **discover** new ideas, encourage students to **distinguish** between prior and newly discovered ideas, and support students to **reflect on and link** ideas.

NLP-Scored Embedded Assessment

Genetics of Extinction: How did the introduction of a predator affect the length of this lizard species' back legs over time?
Plate Tectonics: Mt. Hood is a part of the Cascades mountain range on the west coast in Oregon. Explain how you think the mountain formed.

*Each explanation is scored using **NLP models** for two NGSS Dimensions (DCI, CCC or SEP) and KI. Human-machine agreement Qwk > .75.*

The Teacher Action Planner (TAP)

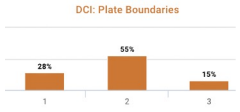
Diverse Student Explanations

"Plates smash into each other"
"Two plates were moved by heat"
"The coast plate is more dense"
"Snow piles up and expands"

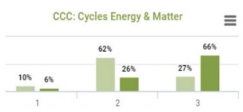
Research-Based Responses

1. List evidence from a model to support or refute: *"plates smash and go up."*
2. Compare evidence with a partner. Form a new claim you both agree on.

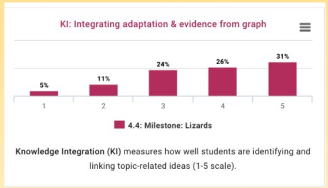
A Pattern of Understanding



A Pattern of Progress



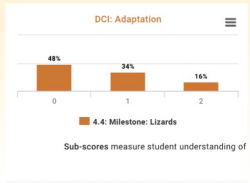
Tchr 1, *Distinguishing*: Using the TAP to Design Adaptive Comments



"From the KI graph, I liked seeing how they were putting together the two ideas – the content and practice - because I feel that is, a lot of the time, what students struggle with"

Response: Adapted and assigned a comment suggested by the TAP to each student's explanation to help distinguish which ideas are supported by evidence and where there is a gap.

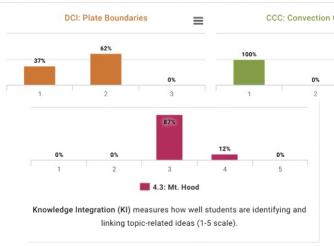
Tchr 2 *Distinguishing*: Using the TAP to Shape Group Discussion



"[The report] gave me a really nice target for our discussion because it was really clear what the major issue was across students. I could prepare based on that, knowing that the majority of students who show up are going to be having an issue with understanding the adaptations concept."

Response: Selected student written explanations featuring common student ideas and gaps to analyze in small group discussion

Tchr 3 *Discovering: Using the TAP to Inform a Review Session*



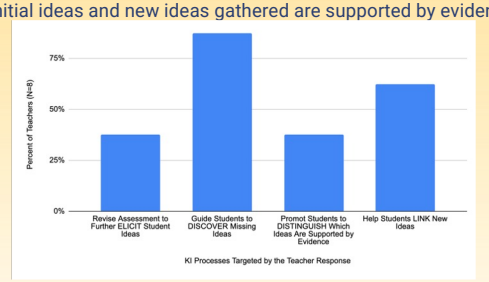
"One thing that I was curious about was convection currents. I also noticed this while teaching. According to the report they [students] haven't made the connection between movement of the plates and convection currents."

Response: Designed a review session to revisit parts of the unit on convection and plate movement, and the different resulting landforms.

Designing Responsive Customizations

Most teachers' customized instruction by helping the class to DISCOVER ideas identified as missing or vague in their explanations.

3 of the 8 teachers engaged students in DISTINGUISHING which of their initial ideas and new ideas gathered are supported by evidence.



How Teachers Selected and Used Evidence of Learning

Compared learning at **2 timepoints to assess and affirm progress**

- 100% of teachers; 29% of interview segments

Evaluated **how students are linking evidence** to inform customization

- 75% of teachers; 32% of interview segments

Analyzed **individual explanations** to check pattern and give comments

- 75% of teachers; 21% of interview segments

Sample Student Explanation:
"Using evidence from the graph, I can tell that the lizards back legs grew over 40 generations. Based on my understanding of natural selection I believe their legs grew because they…adapted to the environment and predators. They grew longer legs to outrun their predators."

Great analysis of the graph. How might the graph explain how legs got longer over time? Natural selection does not involve an organism wishing or willing a change in their body to happen.

Conclusions and Implications

Teachers use the NLP-driven TAP to

- affirm student progress in integrating ideas
- prioritize assessment of linking ideas rather than recall
- respond to class-level patterns of understanding and individual student explanations

Consistent with prior work, most teachers respond to the TAP by supporting discovery. Some respond by encouraging distinguishing among ideas. Redesigns will strengthen evidence for distinguishing.

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