Affective Engagement during Science Argumentation

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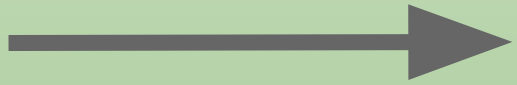
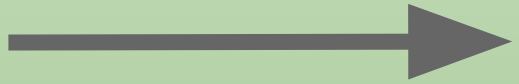
During science learning, shifts in affective states and varying emotions fundamentally shape how engaged a student feels to what they are learning



In the present study, we examine students' science **argumentation and discourse**, and specifically focus on the affective engagement component



We consider affective engagement an exploratory access point to study ***Productive Disciplinary Engagement*** (Engle, 2011)

- students can effectively problematize the subject matter,
- have agency to address content issues,
- are accountable to their peers,
- have access to necessary learning resources

Measuring Science Engagement (Sinatra, Heddy, & Lombardi, 2015)

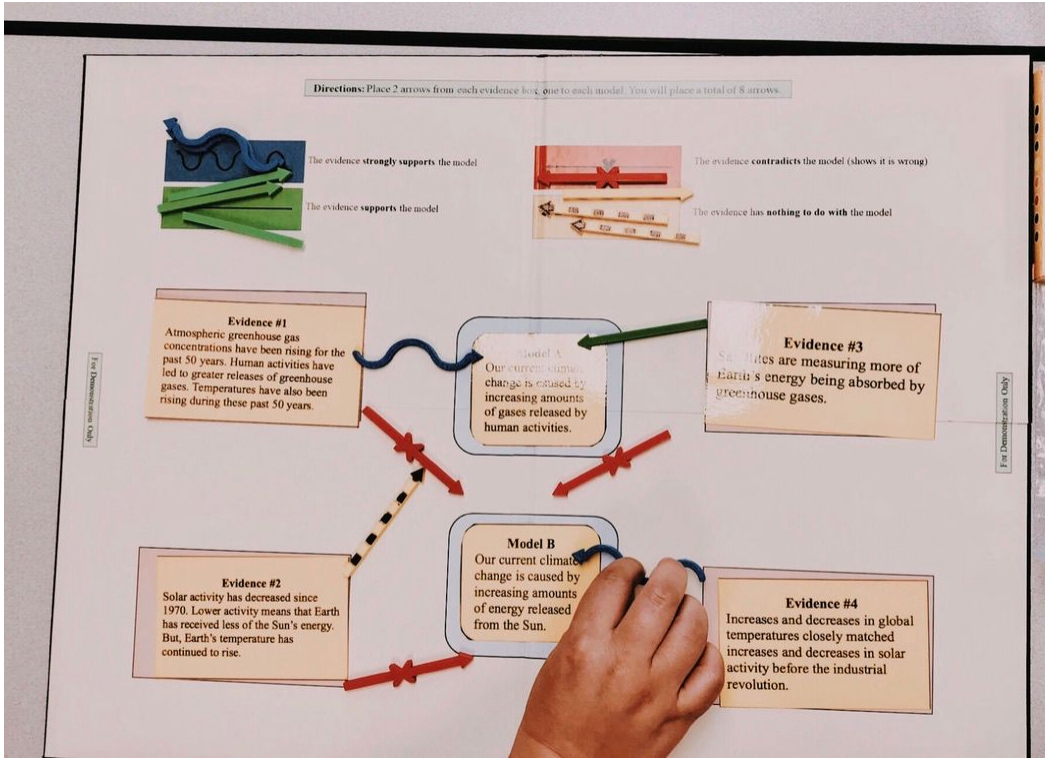
Behavioral Cognitive **Affective** Agentic

Grain-size - Person In Context

Data Collection - Small group in whole class

Measurement - Interaction analysis; Discourse Analysis

The Model-Evidence-Link Diagrams (Lombardi et al., 2018 a; b)



- Learners may encounter multiple conflicting explanatory models when trying to understand socio-scientific phenomena
- Model-Evidence Link (MEL) and build-a-MEL (ba-MEL) diagrams help students to critically evaluate connections between evidence and explanatory models
- Each MEL presents students with four lines of evidence texts and two explanatory models (one scientific and one a plausible, but non-scientific alternative).
- Students draw different types of arrows representing their evaluations of how well each evidence line supports each model, and write explanations justifying their evaluations
- During the process of building their MEL and baMEL diagrams, students work in groups discussing the models, the lines of evidence, and the rationale for their choices.

MELS are an illustrative example of students participating in the ***textual*** *and discourse practices of science learning in order to deepen their understanding of subject matter content*

Emotions

- We classified observed emotions in learner discourse by both level of **activation** (activated/aroused or deactivated/unaroused) and **valence** (positive or negative)

- *"Given the close proximity of epistemic and social emotions to the learning activity itself, studying emotions at this level may be especially fruitful" (Pekrun & Linnenbrink-Garcia, 2014, p. 278).*

Methods

Case study bounded to a single group of middle school Earth Science students (2 m, 2 f; 6th graders)
4 in class observations (plus 1 pre-observation)
Each student group was given an audio recorder which captured their group discourse
Video data from a static camcorder in the back corner of the room to observe general classroom events,
Go-pro camera connected to the teacher, as they visited each student group

Analysis

Transcribed from audio/video recordings from group work
4 rounds of open coding for indications of emotive language or behavior
Triangulated discourse codes found, with audio for tone
Used *a priori* (CVT) constructs to categorize along activation and valence
Secondary analysis for any thematic patterns or characteristics

Results

Learner Emotions

- The process of argumentation activated students' affective engagement, regardless of emotional valence.
- Learner Emotions are activating emotions that motivate individuals to seek or make sense of knowledge in an agentic way

So um... so trilobites? they lived in the salt water right? Creatures that live more than 250 million years ago they lived in salt water. But they're found in Ohio which is five more than 500 miles from where they most commonly lived right?

S3: I had no idea….Artic Norway is filled of tropical leafs called lysocposids….
S2: now called what?
S3: Lyscopids? Lysocosids? Sids? Lyscospids?
S2: Wait. Oh Lycupsid. Maybe? Lycopsids.
S3: Lycopsids…??

S3: These trees lived hundreds of millions of years ago. This is saying that millions of years ago Norway was once a tropical place filled with whatever that thing is called. Whatever that is called.
S2: So would you put that formodel C like strongly supports? Or would you put?
S3: Um... it kinda... what are those things?
S1: Doesn't really... I mean it has a hook... but its not....
S2: yeah maybe we want something that contradicts model C.

Leaf fossils from Wyoming found in a deep rock layer show a climate that is cooler than leaf fossils above it. So this... this one we had a lot of like *confusion*. Cause leaves... so basically by studying... this thing was about how scientists study leaf shapes and they're able to find out like a climate, climate of that environment where a leaf fossil came from. [tone of hesitation, many pauses]

Confusion

Wonder

oh god…So it says leaves that have *teeth around their edges*… *teeth like jagged edges type of thing*… they come from colder climates!

S3: Lycopsids…?? These tree lived hundreds of millions of years ago!! [shouts]

Excitement

It contradicted that idea – the graph clearly shows when there's an increase in fracking, the number of earthquakes also largely increased, right? From the normal? From the average 1.6 per year to 20 then 35, 64, back down to 35 but up to 109 and in recent years it's been up to 584. So you ***gotta find information*** that it was was not caused by fracking, right?

S1 – lets see if it contradicts the idea that its caused by fracking or does it have nothing to do with that idea

S2: Yea! But this hints that the water level was lower, how is that misleading? This is evidence that the water level might have been lower 19,000 year ago. But how does... how is that misleading? That's a good piece of.... I think we should come back to that one.

S1-Yeah. *Do you even see the word fracking there*? (referring to picture in evidence 3)
S2-No, *right. And I'm not saying that just because* that has nothing to do with it, but what this is trying to do is to tell you how an earthquake is formed.
S1-It talks about the tectonic plates, but not how, it doesn't say anything about the modern magnitude – the increase in the modern magnitude of earthquakes in the Midwest, right?-It doesn't say anything about that. Is there anything about that?
S2-When the plate has moved far enough the edges unstick on one of the faults and there's an earthquake
S1-so that's talking about how an earthquake is caused, how an earthquake forms, right?

…. [long pause in discussion]

S2-Why did you put it contradicts, mister?
S1-Because I put – because it talks about – again, reading the last sentence, the long last phrase, 'particularly along faults', right? so that indicates
S2-But then it has nothing to do with it because right here it says Midwest. SO it has nothing to do with it, I'm correct, you're wrong
[group laughter]
S3-I guess you're even here.

S2: But model A says that its misleading to make conclusions based on fossils. Um… this, this is basically saying that coral reefs that need sunlight.
S3: This is misleading because the coral reefs are found down below but sunlight can't reach that far. Even though they are there.
S2: Yea! But this hints that the water level was lower, how is that misleading? This is evidence that the water level might have been lower 19,000 year ago. But how does… how is that misleading? That's a good piece of…. I think we should come back to that one.

Frustration/Heated Exchange

- *Varying emotions are activated during academic activities such as scientific argumentation*

- *Emotional component of scientific argumentation may provide more opportunity for PDE and deeper connection to the area of study.*

Limitations

- Exploratory - can we capture emotions from discourse and interactions?
- Very limited data points for saturation
- We do not currently have coding method in place to interpret and analyze voice and facial cues in a systematic way.
- How do we look across non-interacting groups? Missing context, therefore meaning for interpreting the data across groups
- May want to use self-report data as well, such as experiential sampling surveys in the moment, to check in with emotions.E

Future Directions

- Sequential Analysis and Look Across Groups
  - do certain patterns of conversation lead to certain affective states that then predict PDE and other learning outcomes?
- What about collective or shared emotions/affect? How do we measure that?
  - How are emotions getting constructed together as learning occurs?
  - What impact do those emotions have on learning
    - Need quantitative/network analysis to measure
- Need to create additional valid and reliable approaches to measuring emotions in the classroom.

Thank you!

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