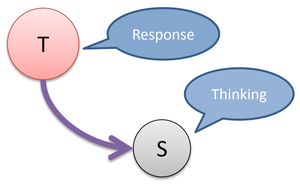
Responsiveness Among Peers Leads to Productive Disciplinary Engagement

Carolina Alvarado[*], Abigail R. Daane[†], Rachel E. Scherr[†] & Genaro Zavala[*]

[*]Department of Physics, Tecnológico de Monterrey *[†]Department of Physics, Seattle Pacific University*

Responsiveness

Teachers 'take up' students' thinking and **respond to student's ideas** in their moment-to-moment interactions.



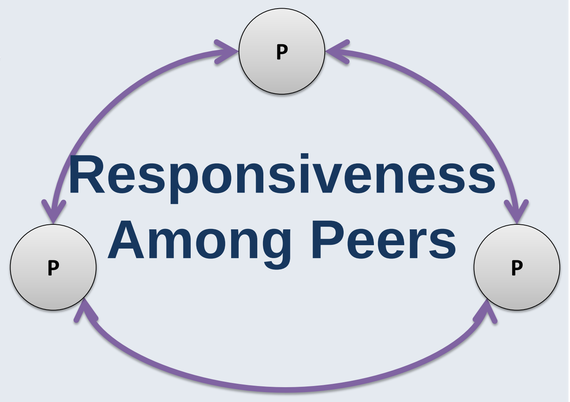
Responsiveness levels (Pierson, 2008)		
Low	L	Teachers do not respond to students' ideas
Medium	M	Teachers use corrective intervention to redirect students' ideas to fit the canonical content such as vague reformulation
High I	HI	Teacher is responsive to the student's idea but the teacher's thinking is on display
High II	HII	Teachers are responsive by building on the student's idea and allowing the student thinking to be displayed.

Productive Disciplinary Engagement

The refinement of argumentation about learners' claims as well as the generation of new questions in response to the discussion.

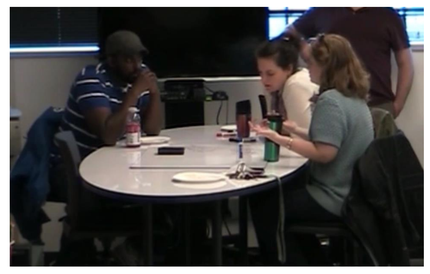
They are getting "somewhere." (Engle & Conant, 2002) .

We propose that responsiveness does not only apply to teacher-student interactions, but also to interactions among peers.



We claim that responsive listening among peers promotes productive disciplinary engagement which results in the refinement of their understanding about energy.

Context

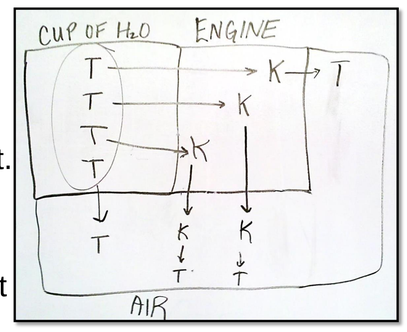


- K-12 teachers professional development course at Seattle Pacific University.
- Course focuses on understanding of energy concepts: energy conservation, usefulness and degradation

Task: Stirling engine

An engine was powered by a temperature difference between a cup of hot water and the environment.

Dicuss how the thermal energy (TE) in the hot water is different from the TE transferred to the environment at the end of the process.



Methodology

We adapted Pierson's code scheme to identify responsiveness among peers.

Stirling engine discussion

I also think that there is also a difference in, what we can get that energy to do or transform into- get some-something that is useful out of it, does that make sense? — [1]Donna

HII — Do you feel like this T [TE in the hot water] is more useful than this T [TE in the environment]? — [2]Larissa

Substantive probe: Larissa creates a space where Donna can further explain her reasoning about the usefulness of thermal energy.

Yeah, and the reason that I am thinking about that is that this energy [TE in the hot water] is more organized. — [3]Donna

You can transfer enough energy to get some motion out of that. Whereas, the air that, once you get the thermal energy in the air, that spreads out. — [4]Donna

M — That's distributed. — [5]Larissa

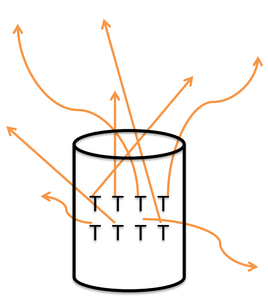
Vague reformulation: Larissa suggests that Donna's description aligns with her own ideas about energy distribution.

It's distributed! I can't go, it is really hard to go back and capture all that to get to do something. Like I can't, I can't just get all the energy, the thermal energy that went into the air and try to run this backwards. — L [6]Donna

Rebroadcasts: Donna takes up Larissa's contribution ("It's distributed!"), she uses an echo that functions as an implicit evaluation of correctness.

Learners' Claim 1: TE flows from the more (hot water) to the less (environment) organized place.

- TE is conserved
- TE difference: *spatial arrangement*
- TE differences: *how they can "use" the energy*



Introduction of cold water

HII — But you were saying, you can't run it backwards [from the less to the more organized] and yet, when I came in we said, well if we put it in water that's colder than the air - — [7]Larissa

Uptake: Larissa reintroduces Donna's idea (dispersed energy cannot be used to run the engine) and proposes to analyze the Stirling engine powered with cold water.

So there has to be a temperature difference, but once they get to the point where there's no temperature difference I can't do it, I can't- — L [8]Donna

Low: Donna explains how the engine works with ice water but does not incorporate Larissa's previous statement.

L — Yeah, yeah. But isn't that backwards taking somehow the distributed energy in the air and making it more organized? — [9]Larissa

Low: Larissa repeats her question, this time a more explicit way; it implies Larissa's determination to discuss her proposed idea.

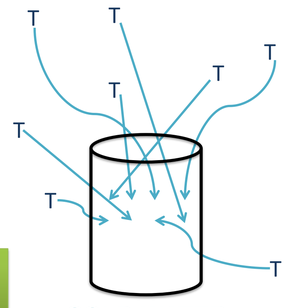
To run it backwards? — HII [10]Donna

Substantive probe: After Larissa clarifies her thinking about the energy flow when using ice water, Donna asks for more information to understand Larissa's idea.

Well if you have cold water then you are (kind of) running it backwards. — [11]Larissa

Learners' Claim 2: TE flows from the hotter (environment) to the colder (cold water) place.

- Stirling engine with cold water
- TE in environment heats up the cold water
- TE flows "backwards": environment → engine → water



Identification of contradiction

HII — So if that's the case, is somehow the less organized thermal energy in the air going in to what we're calling more organized thermal energy in the cup? — [12]Larissa

Contradiction or counterclaim: Larissa reveals the contradiction between the energy flow mechanisms: can the TE transfers from the less to the more organized place?

Hm. Is your point because the energy direction- energy flow would be going from the air to the cup? — HII [13]Donna

Substantive probe: Donna invites Larissa to further explain her concern about the TE in the air flowing or being transferred into the cold-water filled cup.

The thermal energy is going the other- like this all [hot water scenario] is- I'm okay with this, but then suddenly... there is this case where energy transfers in the other direction. — [14]Larissa

Larissa attempts to engage the group in the analysis of the contradiction. At this point of the conversation the group decides to refine their claims by analyzing this inconsistency.

While analyzing cold water scenario, they realized that the claims where contradictory.

- Stirling engine with hot water: *Learners' Claim 1*
- Stirling engine with cold water: *Learners' Claim 2*
- *Claim 1* contradicts their *Claim 2* in the cold water scenario

Responsiveness research has primarily explored the activity of teachers' responsive listening to students' reasoning. (Maskiewicz & Winters, 2012). **In the episodes shown the learners are responsive listeners to each other.**

Learners did not limit their listening to accepting or declining the proposals during their collaboration. **They show a genuine interest to unfold the reasoning of their statements.** They question each other as to how they understand the phenomenon analyzed, and promote each other to give further explanations about their reasoning.

The acceptance and inquiry of their ideas fosters a refinement in their claims about energy organization. We observe that in this discussion, responsive listening among peers leads to PDE. The responsive interventions helped the learners to develop their claims, test the in a new scenario and reconsider them when they noticed an inconsistency.

This work was supported in part by Tecnologico de Monterrey through grant number CAT140, and by the National Science Foundation (DRL 0822342).