How Students Structure Argument through the Interplay of Claims Made about Phenomena and Instructional Tasks

Brian W. Frank

Department of Physics and Astronomy, University of Maine, Orono, ME 04469

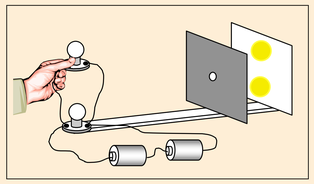
Supported in Part by NSF Grant REC-0633951

1865 THE UNIVERSITY OF MAINE
Physics Education Research Laboratory

Chris and Brent argue about the path taken by light

Chris

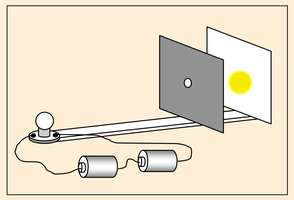
"It's direct, because it's going through that hole and down in a straight line, and to the hole and straight up"



Chris refers back to an observation from earlier, explaining this observation in terms of the straight line idea

Brent

"Right, but the fact that they expand means that it can't be exactly direct, otherwise direct would just be the same size as the hole."



Brent rebuttals by referring back to other evidence, arguing that straight lines implies something they didn't observe.

Elements of Sophisticated Argumentation and Reasoning

Use of evidence to support claims [1]
Reasoning that is mechanistic [2]
Use of rebuttal and counter-factual
Attention to the (in)consistency of ideas [3]

Situating the argument within the instructional task

Chris What do our observations suggest about the path taken by light?

Chris makes a (correct) claim about the behavior of light, which is elaborated upon by Brent

Chris "Its a direct line right to the screen"

Brent "Yeah, from the source, too. It's not just like general light.

Brent "But it can expand"

Brent proposes an additional claim, positioning it as being possibly contradictory with the previous one

David "What question are you on?"

Brent "C"

David and Brent establish they are (still) discussing ideas pertaining to question C

Chris **"Ah...I think it's just...I think. No. I think *they are just talking about* the path."**

Chris makes a claim about what question C is intended to be about, implying that Brent's contribution is outside that intent

Chris and Brent's Argument Occurs Here

Brent "I don't know. ***I just wrote*** its a direct path from the source."

Brent expresses uncertainty, while emphasizing that he did choose to just write the initial answer anyway

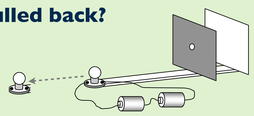
Although an argument is constructed against the idea that light travels in straight lines, the argument is rejected because the idea that light expands is claimed to be outside the intended premise of the question

Brent concedes that he is just going to write that it's a direct path. They seem to have a sense of what the answer they are supposed to write is, even if it seen as inconsistent with other ideas and observations. In doing so, Brent acknowledges a distinction between 'the answer he gives' and 'what he really thinks'

Situating the argument in broader patterns of discourse

Productive Conversations are Thwarted via Claims and Evaluations of Instructional Tasks

What will change when the light is pulled back?



B: Well, it will get dimmer first of all.
C: It'll get dimmer, but I think it'll get bigger, too.
D: The light won't necessarily get dimmer, it'll be-- the light will just be more spread out.
B: I think it will get smaller... If you're pulling it back, I think it'd get smaller. Cause the closer you get, the more it's going to shine through, making it bigger
...

Together, they generate a few different ideas about what will happen when the bulb is pulled back, offering bits of mechanistic reasoning. to support their ideas. Chris expresses doubt about Brent's idea

C: I don't know about that.
B: **Well, we don't have to have the same answers, do we?**
D: I don't think so.
C: **Well I'm just gonna write what I think**. I think it will get dimmer, just cause it's further away. Not as much light is gonna reach that hole.
B: Exactly.
C: But, I think in the same sense, it's going to be more light that's gonna…ah…ah… I don't know.
B: **We shall see. I don't think it's a big deal.**
C: Yeah and we gotta do part B also?

Brent dismisses Chris' doubt about Brent's answer, as well as Chris' confusion about his own reasoning. In doing so, the conversation shifts from what they think to what they are going to write down as answers

Students Negotiate and Clarify Contributions as either 'Answers' or 'Thoughts'

B: **I'm gonna say it will** behave the same way, except in the shape of a triangle. *[begins writing]*
C: **Yeah, but do you think it will** be a triangle?
B: Yeah. It will be a triangle, why wouldn't it be?
D: It's shaping it.
B: The best part is, I don't think they care if it's right or wrong, anyway.

Brent make his answer for a question publicly known.

Chris doesn't seem to expect that what Brent writes down will necessarily correspond to what he thinks.

Brent makes a claim about the relative importance of the instructional task, dismissing relevance of Chris' inquiry

Understanding Brent and Chris' classroom participation

Claims about the nature and importance of instructional tasks mediate the substantive aspects of the students' arguments about phenomena.

Although Brent and Chris exhibit many elements of sophisticated argumentation and scientific reasoning, they utilize claims and evaluations of instructional tasks as leverage to undermine or dismiss the relevance of having to contend with counter-claims and rebuttals, expressions of doubt about the certainty of ideas, and potential sources of confusion or inconsistency.

The premise for their argumentation resides in tension between (i) making genuine inquiries about phenomena and (ii) offering sufficient answers

Researchers continue to distinguish between two kinds of epistemological engagement: 'doing school' vs. 'doing science' [4], 'answer-making' vs. 'sense-making' [5], etc. This distinction is reflected in the variability of Chris' and Brent's classroom behavior. Interestingly, Brent and Chris themselves seem to acknowledge this distinction, at times, requesting clarification about the nature of a statement, or specifying whether a particular contribution corresponds or does not correspond to what they actually think.

Their participation sometimes limits the opportunities they have to address their own misunderstanding and refine their ideas about the phenomena

Many of the arguments Brent and Chris have concern common misunderstandings about light that have been documented in the literature (e.g., expansion) [6], but they are not always ones that explicitly addressed by the curriculum. For researchers, understanding how students like Chris and Brent engage in authentic inquiry within the constraints of instructional tasks, offers insight into how students *frame* [9] their instructional activity and how their perceptions shape the roles they take up as learners.

Abbreviated List of References

[1] Kuhn (1991)
[2] Russ, Scherr, Hammer, & Mikeska (2008)
[3] Sikorksi, Winters, & Hammer (2009)
[4] Jiménez-Aleixandre, Rodríguez 1, Duschl (2000)
[5] Hutchison & Hammer (2010)
[6] Gaili & Hazan (2000)
[7] McDermott, Shaffer, & PEG Group (1998)
[8] Morgan & Wittmann (Online resource)
[9] Hammer, Scherr, Elby, and Redish (2005)