

Framing Analysis Lite: A Tool for Teacher Educators

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Abstract: A teachers' *framing* of their classroom interactions with students—their sense of “what’s going on here”—affects whether they attend and respond to the substance of students’ thinking, a central pillar of effective teaching in mathematics and science. Therefore, teacher educators would benefit from knowing how their pre-service teacher interns (aka student teachers) are framing their various classroom interactions. Unfortunately, detailed framing analysis typically relies on Interaction Analysis of video recordings. Teacher educators rarely have the access and time needed to collect and analyze such data. More commonly, teacher educators obtain pre-service teachers’ written reflections about their classroom interactions. We argue that a “lite” version of framing analysis allows teacher educators to infer at least a rough sense of how pre-service teachers are framing various classroom episodes, and this rough framing attribution is “instructionally actionable” in that it can inform the teacher educator’s next steps with pre-service teachers.

Major issue addressed: Inferring pre-service teachers’ framings of their classroom interactions from limited data

Previous work has shown that teachers’ framing of the classroom activity—their sense of “what is it that’s going on here” (Goffman, 1974)—affects the extent to which and ways in which they notice, interpret, and respond to the substance of students’ thinking (e.g., Lau, 2010; Richards, Elby, Luna, Robertson, Levin, & Nyggen, 2020; Robertson, Richards, Elby, & Walkoe, 2015; Russ & Luna, 2013). For this reason, some “teacher noticing” researchers have argued that teacher educators should attend carefully to how their pre-service teachers are framing their classroom interactions in their K-12 teaching placements and should help pre-service teachers (re)frame their classroom activities in ways that support their attention to student thinking (Russ & Luna, 2013, 2013; Richards et al., 2020). This proposal is potentially a non-starter, however, because exploring how teachers frame classroom activity typically relies on close analysis of classroom discourse, often using tools from conversation analysis and interaction analysis. Teacher educators have limited time and opportunities to observe their pre-service teachers “in action” in K-12 classrooms or to watch video of those interactions and conduct close analysis of the discourse.

By contrast, in their teaching methods courses, teacher educators commonly elicit and provide feedback on pre-service teachers’ written reflections about their classroom experiences. In this paper, we argue that these written reflections can provide actionable insights into how the pre-service teachers were framing their classroom interactions. For numerous reasons discussed below, such data lacks the richness or reliability to ground high-quality research on pre-service teachers’ framings. Nonetheless, from the written reflections, teacher educators can infer rough guesses about pre-service teachers’ framings, inferences that can inform the teacher educator’s next steps in helping the pre-service teacher make progress toward more consistent noticing of the substance of their students’ thinking.

To make this case, we analyze written reflections from “Katie,” who was taking a course centered around noticing students’ thinking.

Potential significance of the work

Prior research in mathematics and science education has demonstrated that students gain deeper conceptual understanding in classrooms where teachers intentionally listen to, make sense of, and respond to students’ ideas (e.g. Ball, 1993; Saxe, Gearhart, & Seltzer, 1999; Pierson, 2008; Kersting, Givvin, Sotelo, & Stigler, 2010; Radoff, Robertson, Fargason, & Goldberg, 2018). Prior research has also demonstrated that teachers vary in their noticing and responsiveness to the substance of students’ thinking, and this is particularly true among pre-service and novice teachers (e.g., Levin, Coffey, & Hammer, 2009; Russ & Luna, 2013). From this prior work, we know pre-service teachers *can* attend to students’ thinking, but sometimes or often do not. As we have argued in previous work (Richards et al., 2020), this variation can be partly explained by teachers’ framings of classroom activity—their sense of “what is it that’s going on here” (Goffman, 1974)—because a given framing is reflexively linked to

which skills and knowledge the teacher brings to bear, what beliefs about knowledge and learning are activated, and which constraints are foregrounded vs. backgrounded in the teacher's decision-making. For this reason, insight into pre-service teachers' framings of classroom activity can become a powerful tool for teacher educators to use in their work with novice teachers learning to notice, interpret, and respond to the substance of their students' thinking.

As noted above, however, gaining this insight is time intensive when sought through interaction-analytical techniques applied to classroom video—time most teacher educators do not have. In this paper, we address this challenge by showing that teacher educators can use written reflection data to infer pre-service teacher's framings. Although this result is significant in itself, as argued above, the broader significance of this work is its illustration of a needed research agenda for making learning sciences approaches increasingly practicable: how can “lite” versions of analytical techniques developed in the learning sciences be used by time-constrained teacher educators and/or teachers to better understand crucial aspects of their students' reasoning and practices?

Theoretical and methodological approach

Background and case selection

Katie was a Learning Assistant in the Physics Department at a small private university in the Pacific Northwest United States. Learning Assistants (LAs) work as undergraduate teaching assistants in reform-oriented introductory physics courses (Otero, Pollock, & Finkelstein, 2010). In their placements, LAs facilitate collaborative dialogue among groups of physics students in a combined lecture and lab course. Simultaneously, LAs take a pedagogy course designed to help them learn to teach physics as they support their students in learning to do physics. Katie's LA pedagogy course focused on helping LAs attend and respond to students' ideas, specifically the “seeds of science” (i.e. beginnings of scientific understandings) (Hammer & van Zee, 2006) present in students' ideas, even when those ideas are canonically incorrect. Course activities included reading journal articles about responsiveness to student thinking (e.g., Ball, 1993; Hammer, 1997) and watching and unpacking classroom video.

Convenience led us to choose Katie for this illustrative case. In a previous study (Richards et al. 2020), we analyzed Katie's written reflections in ways that served as the starting point for the analysis below. The previous study explored how best to explain novice teachers' variability in their attention and responsiveness to the substance of students' thinking across class sessions, and Katie's written reflections contained evidence of such variability. As part of this previous work, we conducted a framing analysis of three novice teachers' practice, including Katie's. For two of these teachers we had both classroom video and teacher interview data; but with Katie, we only had her written reflection data. For this reason, we were skeptical as to whether or not such a framing analysis was possible, yet we found that it could be done! However, because the analysis of Katie differed in methods and depth from the other two analyses, we did not use Katie's case in the final manuscript. This paper makes the emergent point that it's possible to infer Katie's framing, at least roughly, from her written reflections.

The excerpts below come from Katie's teaching journal, submitted weekly, which documented her students' ideas and how these ideas informed her practice. The assignment read:

As in previous weeks, please keep a teaching journal as you interact with students this week... I recommend that you focus on specific “seeds” that you notice in student talk and action this week and how you followed up on them (or how you could think about following up on them, retrospectively). Please provide enough detail that someone who was not there can understand the interaction (e.g., what did the students say, how did you interpret it/what did you see in it, how did you respond).

Analytical tools: Framing analysis lite

We use two analytical strategies to focus on evidence of framing in Katie's written reflections. First, previous research has shown that (a) epistemological beliefs about how students learn, and (b) perceptions of constraints (e.g., Radoff, Robertson, Fargason, & Goldberg, 2018; Rop, 2002) influence teachers' decision-making about what kinds of classroom discourse to draw on or suppress, which in turn is reflexively related to how they are framing the activity. For this reason, in analyzing Katie's reflections, we focus on her explicitly stated and her enacted beliefs about these topics. Consistent with situated perspectives on cognition and with the “knowledge in pieces” perspective, we assume that these “beliefs” may exhibit context dependence (Hammer, Elby, Scherr, & Redish, 2005; van de Sande & Greeno, 2012), and hence it's an empirical matter whether Katie displays the same

beliefs across different classroom reflections. Second, we focus—to the extent afforded by written recollections—on positioning; specifically, (i) how Katie positions herself and the students and on (ii) the structure of the discourse. A given combination of a positioning and a discourse structure will be consistent with some framings but not others, and hence, these are aspects of videotaped classroom discourse that an interaction analysis would target in inferring a framing of the classroom activity.

We now discuss these two analytical strategies in more detail.

Analytical strategy 1: Focus on beliefs about how students learn and perceptions of constraints

Drawing on indicators of teachers' more "constructivist" vs. more "transmissionist" epistemological beliefs as inferred from their statements about teaching and learning (Brickhouse, 1990; McRobbie & Tobin, 1995; Wallace & Kang, 2004), our strongest evidence consists of direct statements such as "I told my students they needed to figure it out for themselves," from which we infer that the teacher in that moment is thinking that students learn by constructing their own understanding. Higher-inference belief attributions came from how the LA claimed to organize the discourse. For instance, giving an extended "mini-lecture" before letting students work on what was intended to be a "lecture free" collaborative activity suggests that a transmissionist belief was cued up during that segment. Again, we assume these "beliefs" can depend on contextual cues.

Evidence that perceptions of external constraints were potentially influencing the teacher's framing came from explicit statements of feeling time pressure, lacking needed equipment, or the like.

Analytical strategy 2: Focus on positioning

Positioning moves (Harré, Moghaddam, Cairnie, Rothbart, & Sabat, 2009) as analyzed in classroom interactions (e.g., Anderson, 2009; Herbel-Eisenmann, Wagner, Johnson, Suh, & Figueras, 2015) give insights into which roles and responsibilities (Goffman, 1974) the teacher takes on, and which roles students (or particular students) are encouraged or allowed to assume. In classroom discussions that center on students' ideas, the positioning of students is entangled with taking up, ignoring, or dismissing students' ideas. Although the LA's written reflections provide at best a veiled and potentially biased view of positioning moves, we look for clues such as "students sustained their debate with no nudges from me," which positions students as the knowledge-creators, or "I explained how the circuit really works," which positions the LA as the source and/or arbiter of knowledge claims.

We call the combination of these two analytical strategies "framing analysis lite" because it lacks the richness and reliability of a framing analysis of video recorded classroom interactions. The point of this paper is to illustrate that framing analysis lite can provide instructionally actionable insights to the teacher educator reading the written reflection.

Major findings

We present a "framing analysis lite" of two consecutive teaching reflections from Katie, the first from a lesson she taught on Newton's 3rd Law and the second from a lesson she taught on Electrostatics. Our analysis of Katie's written reflections of these lessons highlighted two of Katie's framings, one of which supported her in being much more responsive to students' thinking than the other. We first present her reflection on each lesson and our quick, coarse-grained analysis of her self-reported attention and responsiveness to the substance of student thinking. Then we show how these reflections reveal differences in her (foregrounded) beliefs about learning, her perceptions of constraints, and her positioning moves—differences that provide insight into the different ways she was framing these two lessons. This difference in framing, we argue, can help explain the variability in Katie's attention and responsiveness to her students' thinking and can point toward possible next steps a teacher educator might take with her.

Newton's 3rd Law lesson: Evidence of Katie's responsiveness to student thinking

Teaching in a physics course for non-majors, Katie facilitated a discussion of Newton's 3rd law. This law captures the essence of forces as interactions, telling us that the magnitude of the force that object 1 exerts on object 2 must equal the magnitude of the force exerted by object 2 on object 1. For example, if someone pushes on their bedroom wall, the wall pushes back equally hard. In her lesson reflection, Katie wrote:

Today in [class] we were having a discussion about Newton's third law and how it can be that if I push someone into the street, he must push me back by exactly the same amount, but I do not fall into the street as well. One student said that it was because I am grounded and expecting it, while the other person is not. I saw in this a seed of canonical correctness, which is what I was hoping for in the conversation. We were having a pretty scientific discussion already so I was not so worried about fostering a more scientific environment. What we were all looking for

was a resolution to our paradox. I thought that this seed could be helpful but it might need some help to really get it there, so I said that it seemed like what the student was getting at was something about how we were making the ground push against us as well. He agreed, and designed a thought experiment about what would happen if he pushed someone in space (seed of scientific practice!) which I thought was awesome.

We see evidence of attention and responsiveness to the substance of student thinking in this recounting. Katie attended to the student's notion of "grounded," saw a connection between this idea and a more canonical explanation of the scenario in terms of the grounded student pushing off the street, and revoiced her refinement of the student's "grounded" idea in the discussion. Then, Katie described both the conceptual substance (pushing, but now in outer space) and the "seed of scientific practice" ("design[ing] a thought experiment") in the student's response.

Electrostatics lesson: Less responsive to the substance of student thinking

Less than two weeks later, Katie again reflected on her teaching, this time in a third-quarter calculus-based introductory physics course. In this lesson, students were completing a *Tutorial* (guided inquiry module for small-group work; McDermott & Schaffer, 1998) on interactions between charged objects. Students had observed a negatively-charged rod repelling a small, negatively-charged pith ball. They were asked to imagine adding a second negatively-charged rod to the scenario, farther from the pith ball than the original rod. The *Tutorial* asked students to predict whether the second rod would exert a force on the pith ball. Katie wrote:

I noticed today that it was difficult for me to help students discover things themselves rather than just explaining answers. I really want students to have agency in their learning, but I have no idea what questions to ask and it seemed like sometimes the experiments weren't working the way I expected. At one table, they predicted that adding a second charged rod would have no effect on a pith ball because the forces cancel. I wanted to just say no, that is only true between the rods, but then I realized we could just test it. We did, and they saw that the second rod did exert a force on the pith ball. They agreed that this was happening, but I had a really hard time reconciling the reasoning so I did more talking and explaining than I feel like I should have or wanted to.

Katie then expressed similar frustration about her response to students' discussion of a phenomenon they'd found later in the *Tutorial*. Students noticed that an uncharged pith ball was originally attracted to a negatively-charged rod; but as soon as the pith ball touched the rod, the rod repelled the pith ball.

A seed I noticed at several tables was students noticing that the pith balls were initially attracted to the rods, but then when they touched the ball would immediately repel. This was awesome for two reasons. First, they were noticing something strange and asking why it happened (very science-y). Second, this was a question they were totally capable of answering for themselves. I tried to help them come up with an explanation that came mostly from the students' ideas about transferring charge and induced dipoles, (1) but sometimes I felt like I had to suggest things (like the induced dipole) that they might not easily think of on their own. Had we had a lot more time, they might have, but I don't feel like this was something we could spend the whole class period on. Also, I found out later that the tutorial goes over induced dipoles at the end, and it kind of just told them about it rather than guiding them through.

In this reflection, we note Katie's own evaluation of having a "hard time" facilitating these discussions as she envisioned and also see less evidence of her attending and responding to the substance of students' ideas than we did in her previous reflection. In her first excerpt, she noted that she "did more talking or explaining than [she] feel[s] [she] should have or wanted to," and she foregrounded the incorrectness of students' predictions. In her second excerpt, she said she "felt like [she] had to suggest things that...[students] might not easily think of on their own"; even as she noted the "awesome" nature of their ideas, her response oriented toward what canonically correct ideas were not yet evident. Indeed, unlike in the Newton's 3rd law reflection, she did not describe much about students' reasoning, primarily citing their predictions and observations and general notions of ideas like "transferring charge."

Katie' framings: Explaining why Katie is more responsive to students' thinking in one

lesson than she is in the other

By first examining Katie's beliefs about how students learn and her perceptions of constraints (analytical strategy 1), then examining her positioning moves and attributions (analytical strategy 2), we characterize how Katie framed the two classroom episodes. Acknowledging that these framing attributions are perhaps crude approximations, we then argue that they are sufficient to help explain the differences between Katie's attention to the substance of student thinking across the two episodes, and sufficient to guide a teacher educator's next steps with Katie.

Katie's beliefs and perceptions of constraints

Katie's expressed preferences of not wanting to talk or explain as much as she did in the electrostatics lesson reflect a set of beliefs about learning that were similar across the two reflections. In the Newton's 3rd law reflection, she called it "awesome" that a student designed a thought experiment to test his own idea, and she valued that students were having a "scientific" discussion (which she associated with student-directed sensemaking, as evidenced by other teaching reflections). Similarly, in the electrostatics reflection, she expressed a desire for students to "have agency in their learning" and to "discover things themselves," and disappointment that her actions may have communicated otherwise. She also described students' wondering about their pith ball observation as "awesome" and something she felt "they were totally capable of answering for themselves."

In both reflections, Katie also prioritized students getting to the right answer. In the first, she said that "seeds of canonical correctness" (*i.e.*, seeds of the correct answer) were what she "was hoping for in the conversation"; in the second, she "had to" suggest ideas when these ideas were needed to get the right answer. Together, these quotes point to Katie's (partly) constructivist belief that meaningful learning occurs when students build from their existing ideas toward correct answers, and this belief permeated her reflections in all of the interactions she described. Thus, the differences in Katie's attention and responsiveness across the two classes cannot be well-explained in terms of activation of different sets of beliefs; she did not display more "constructivist" beliefs in the context of one lesson and more "transmissionist" beliefs in the context of the other, at least according to her reflections.

At first glance, perceptions of constraints may help account for Katie's differing attention and responsiveness to student thinking in these two reflections. In the electrostatics lesson, when the experiments "weren't working [as] expected" and students' contributions did not yet include important ideas for explaining the phenomenon, Katie felt the need to intervene by "suggest[ing] things." Crucially, she noted that "had we had a lot more time, they might have [come up with such ideas on their own], but I don't feel like this was something we could spend the whole class period on," indicating that Katie saw time constraints as affecting her in-the-moment decisions in the electrostatics lesson.

However, note that in considering perceptions of constraints in the electrostatics lesson, we needed to also consider the flow of classroom activity—experiments not working, and students' answers not containing seeds Katie felt she could build upon—and its impact on the roles and responsibilities the teacher takes on, as well as those students are encouraged or allowed to assume. This points us toward close attention to Katie's positioning moves and attributions.

Positioning moves and attributions

Describing the Newton's 3rd law lesson, Katie wrote that "what we were all looking for was a resolution to our paradox" in the context of Newton's third law, notably referring to the paradox as *ours*; she positioned it as an authentic question on the part of students, and she saw herself in a helping role, working *with* students to resolve it. Further, Katie saw the conversation as a "pretty scientific discussion already," not requiring her to take on a "teacherly" role. And she saw the student's "grounded" idea as a productive seed that she could help students build on, rather than needing to point them in a new direction. The student then took up Katie's suggested idea by building it into his own sensemaking (with the pushing in outer space thought experiment), further sustaining the positioning of Katie and the students as collaborative sense-makers. In brief, Katie positioned herself not as a teacher, but rather, as a collaborator or helper in the sense-making.

The electrostatics lesson played out differently, even though Katie (according to her reflection) expressed desire for a framing similar to that of the Newton's 3rd law lesson. She started her reflection by emphasizing that "it was difficult for me to help students discover things themselves rather than just explaining answers," suggesting that she wanted to help students make sense of the phenomena and the explanations invited by the *Tutorial* and to "have agency in their learning." However, unexpected experimental results pointing students toward incorrect explanations, and hence students not offering "seeds" Katie could build on, may have led Katie to position herself more as a traditional teacher: she wrote that she did "more talking and explaining than I feel like I should have or wanted to" and that "I had to suggest things... that they might not easily think of on their own."

How Katie framed the two classroom episodes

In the Newton's 3rd law episode, at least according to Katie's reflection, she saw learning as building on seeds toward correct understanding and she saw students as indeed making progress toward correctness; she didn't mention time pressure or other such constraints; and she positioned herself as a collaborator/helper in the students' sensemaking. These factors support the inference that she sustained a framing of the classroom activity as something like *collaboratively making sense of a paradox*, which in turn afforded Katie's attending and responding to the substance of student thinking in ways that may have reinforced this framing.

By contrast, in the electrostatic episode, a different framing emerged, something like *explaining phenomena through a leading dialogue* or *covering content through a leading dialogue*. Evidence for a framing of this type comes from (i) her unease when "experiments weren't working the way I expected," since explanations of faulty results will themselves be faulty, violating her belief in the importance of students' reaching correct answers; (ii) her positioning herself as a traditional teacher when she wasn't sure how students' reasoning could contribute to explanations for the observed phenomena; and (iii) her feeling of time pressure in trying to reach the instructional goal of the *Tutorial*, which was an explanation of induced dipoles. (Her note about this *Tutorial* content was placed right after her discussion of time constraints, functioning to bolster her explanation of why it might have been okay for her to do more explaining than she had initially intended.)

In this framing, while Katie expressed both pieces of her (partly) constructivist belief that learning involves students building from their existing ideas toward correct answers, the "toward correct answers" piece was foregrounded, while the piece about building from student understandings was backgrounded but still likely active given her eliciting of and desire to reconcile correct explanations with what students offered. We could also model her (partly) constructivist belief as temporarily inactive in the classroom moments during which she provided explanations, though active in her reflections of those moments. Either way, attributing to Katie a framing like *explaining phenomena through a leading dialogue* in the electrostatics class helps to describe and explain the coupling of her perception of time constraints to her belief about learning (with the "toward correct answers" piece foregrounded), in the context of what she depicted as emergently challenging classroom interactions. In any case, this framing would be consistent with Katie's attending to whether students were following her explanations, but it doesn't afford sustained elicitation of and attention to the substance of students' thinking.

Conclusions and implications

Our "framing analysis lite" approach provides insights into Katie's framing in each of the two lessons, framings that we inferred from 1) beliefs and/or perceptions of constraints that she articulates and 2) the ways in which she positions herself and her students in her written reflections.

As we have discussed, we are not arguing that this analytical approach is adequate for research purposes to establish how a novice teacher is framing various classroom interactions. The limited data relies simply on what Katie chose to include in response to the journal prompt, and she likely left out other details that would provide a more nuanced analysis of her framing. Similarly, the data solely consists of Katie's own recollection and interpretation of events and of her thinking. We argue, however, that this "lite" version of framing analysis, using the analytical strategies we illustrated, provide a "good enough" analysis of how pre-service teachers frame classroom interactions to guide teacher educators seeking to support their students in developing practices of attending and responding to the substance of students' thinking. In other words, such analysis can provide instructionally actionable insights to the teacher educator. The lite analysis provides an analytical lens for teacher educators choosing to use reflection-on-practice assignments for formative assessment purposes as feedback to modify instruction (Black & William, 1998).

For example, our use of the framing analysis here suggests that Katie's epistemological beliefs are likely productive under the right set of circumstances; she clearly cares about her students drawing on their existing ideas and helping them use those ideas to arrive at canonically-correct answers. Her frustration, and her lesser attention to students' ideas in reflecting on the electrostatics lesson, appear to arise when these beliefs intersect with her concerns about the time available for this kind of "discovery," tipping her into a framing in which she plays a more traditional teacher role. A teacher educator working with Katie might approach this by providing substantive feedback on Katie's reflections to acknowledge the consistency of her beliefs and the importance of her goals, while gently de-emphasizing the time constraints. Through written comments and elevation of expressed tensions for class discussion, the instructor could help Katie to see that it's okay if a science discussion doesn't always end with students arriving at the right answer. Aspects of Katie's beliefs are consistent with the following case her teacher educator could make: There are equally valuable goals from science discussions as students learn to articulate their ideas, engage in scientific reasoning, and critically evaluate others' ideas. To help Katie become more consistently responsive to the substance of students' thinking, her instructor might also ask

her to consider over what timescale students need to get the right answer, opening up the possibility that it is okay to take time and space to engage students in substantive discourse, even if this sometimes means that it takes a little longer (maybe additional class periods) for the class to make progress toward canonical ideas. Katie might be encouraged to reframe these discussions as opportunities for students to get started and make progress. In practice, a teacher educator engaging in this analysis might find some patterns among her students. Katie's instructor, for example, might see similar patterns, or others, that she wants to address with the class as a whole.

We acknowledge that teacher educators working with pre-service K-12 teachers might show different patterns of framings than those exhibited by Katie and other learning assistants, who teach undergraduates. For instance, we might expect framings to influence and be influenced by the pre-service K-12 teachers' views of what students are capable of; teachers sometimes categorize students as "high" and "low" achievers and take different approaches to teaching those two types of students (Edwards, 2010). Our argument, however, is methodological: using written reflections, it is feasible and productive for teacher educators to develop a rough sense of pre-service teachers' framings of their classroom activities. In analyzing those written reflections, the teacher educator can be attuned to factors that might influence those framings, such as harmful cultural narratives about high and low achieving students.

Written reflections of teaching experiences are common in teacher education (e.g. Davis, 2006; Hoover, 1994), and prompts asking for pre-service teachers to focus on productive seeds of thinking are increasingly common among teacher educators wishing to promote attention and responsiveness to student thinking (e.g., Levin, Chumbley, Jardine, Grosser-Clarkson, & Elby, 2018). Considering the widespread use of these kinds of assignments, it is important for those of us who work with teacher educators to provide some support in what they might learn from analysis of their students' written reflections. The "framing analysis lite" approach provides a lens through which teacher educators can use these reflection assignments productively for formative assessment in the service of supporting pre-service teachers' responsiveness to the substance of students' thinking.

Finally, in addition to illustrating how "framing analysis lite" can become a tool for teacher educators, this work also illustrates the broader need for a research agenda of adapting learning sciences analytical approaches to be of use by educators. We think there are other "lite" versions of analytical techniques developed in the learning sciences that can be used by time-constrained teacher educators and/or teachers to better understand crucial aspects of students' reasoning and practices.

Endnotes

(1) Briefly, there are two possible explanations for why a neutral object may interact with a charged object. One is that charge is transferred to the neutral object so that it becomes charged. The other represents the neutral object as containing equal numbers of positive and negative charges, the latter of which can move. If a charged object is brought close to the neutral object, some of the charges within the neutral object move so that each side of the object has a net charge. For example, if a negatively-charged object is brought close to a neutral object, some of the negative charges within the neutral object will be repelled and so move to the side of the neutral object that is opposite to the location of the charged object. This will leave a net positive charge on the side of the neutral object closest to the negatively-charged object, and so the two objects will attract.

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