A Multidimensional Framework of Group Productive Disciplinary Engagement

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Abstract: This research is aimed at developing theory and methods to examine collaborative group engagement during classroom activity that integrates math and science disciplinary practices (i.e., modeling, argumentation). This work draws on a situative perspective, along with prior framings of individual and group engagement, to conceptualize engagement as shared and multidimensional. Case illustrations showcase the synergistic interrelations of multiple dimensions, together constituting productive disciplinary engagement. Application of the rubric includes instructional design and practice.

This research is aimed at advancing theory and methods for understanding how collaborative groups come to productive forms of engagement in STEM activities. This research builds from Engle and Conant's (2002) conceptualization of *productive disciplinary engagement* (PDE) as collective intellectual progress on core ideas and scientific and mathematics practices during authentic tasks by a) broadening the analytic focus to encompass collaborative groups' collective engagement and b) describing groups' engagement as multifaceted, with dimensions operating in synergy, drawing on extant conceptualizations of individual's engagement (Fredricks, Blumenfeld & Paris, 2004). In alignment with a situative perspective, we conceptualize engagement as social and representative of the negotiated norms of activity, including shared group norms (Sinha, Rogat, Adams-Wiggins & Hmelo-Silver, 2015). A multidimensional conceptualization of engagement enables examination of individual engagement dimensions that together constitute PDE. This multifaceted approach is aligned with aims to understand the interconnections between social and cognitive dimensions during group activity (Barron, 2003) and situative views' regard of behavioral, social, emotional, and cognitive facets of engagement as central to and inseparable from group learning (Gresalfi, Martin, Hand & Greeno, 2009).

We specify five dimensions of collective group engagement: *Behavioral engagement (BE)* comprises groups' joint on-task engagement. *Socioemotional engagement (SE)* involves the group's climate, characterized by respectful, inclusive, and cohesive interactions. *Collaborative engagement (CE)* considers the group's coordination and responsiveness in making contributions when co-constructing knowledge. *Metacognitive engagement (ME)* is group planning and monitoring (i.e., joint regulation) toward content and/or disciplinary practice understanding. Finally, *disciplinary engagement (DE)* refers to forming connections that integrate conceptual and disciplinary competencies, supported by rationale. In this paper, we examine interrelations among these five dimensions using two contrasting case examples, as well as one group's engagement in depth.

Method

PDE is examined in collaborative tasks involving modeling and argumentation in middle school math and science. We draw on a rich corpus of video data collected as part of three curriculum design projects where group work was central to unit goals. The range of domains, disciplinary practices and curricular features (e.g., technology tools, scaffolds) of the data corpus enriched theoretical development efforts. We developed a rubric that characterized five dimensions of engagement using 3-point rating scales, with DE specified using a 4-point scale.

Results

Figure 1 presents PDE ratings for two 5-minute video segments for two groups, showcasing high-level DE (3 or 4 ratings; n=19), but with contrasting ratings in the other 4 dimensions. Group A's engagement ratings suggest mutual support of sustained high-level ratings across dimensions fostered DE (see in-depth analysis). In contrast, Group B faced challenges with group climate and coordination (SE, CE), as the group rejected a groupmate's contribution and belittled their competence. This rebounded somewhat in the second segment, but limited collaborative knowledge building (CE) and monitoring focused on task completion (ME) yielded moderate-high DE, despite a rich task focused on explaining the evolution of finches.

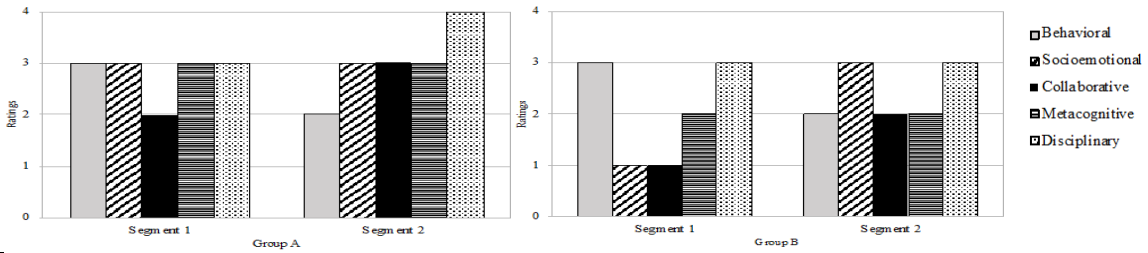

Figure 1. PDE ratings: Group A (left) and B (right).

In their math class, Group A is made up of three females who are asked to interpret a line graph depicting motion of two vehicles over time (i.e., their speed). One student, Abby raises a question based on her metacognitive monitoring concerning how to read the graph. Beth and Abby's initial interactions illustrate both girls voicing a common misunderstanding that the line graph represents the physical characteristics of one of the vehicles' routes and rely on the simple recall of the slope formula. Abby's questions about the meaning of the slope formula (ME) as related to the graph elicited group DE. Her questions included, "I don't get how it [the graph] can describe the motion…They're just lines. It doesn't say describe the graph, it says to describe the bus and the van" and "For one second, does that mean? Like what distance and what time?"

The group's brief off-task exchanges (BE) involved positive socioemotional interactions which fostered team cohesion (SE). Abby returns to task (BE) and persists in raising a question regarding her uncertainty in interpreting the line graph (ME; DE). "Beth, so I don't get how they can just be…how can they go the same amount of miles and still go at the same speed? Like, it just doesn't make sense." Beth and Carly remain responsive to Abby's questions (CE) and their support enables Abby to negotiate their working understanding of the different speeds of the van and bus while gesturing to her graph (DE), "Actually, the bus still is going at a faster speed. Its speed would be faster than the van. Just because it stopped doesn't mean the speed changed, right?"

This case showcases how the five-engagement dimensions interrelated in ways that afforded the intellectual progress at the integration of mathematical practice (generating a model) and content (conceptual understanding of slope). Abby's persistence (BE) and negotiating her understanding during sustained uncertainty (DE) was facilitated by her metacognitive monitoring of her understanding concerning how to interpret the graphic representation of speed and the meaning behind the slope formula and different vehicle speeds (ME). Carly and Beth's high-quality collaborative engagement was responsive to Abby's questions, facilitated by group cohesion established in off-task interactions (SE), and contributed to their knowledge co-construction (CE).

Discussion

We aimed to showcase the affordances of our theoretical framework and developed rubrics for evaluating collaborative groups' productive engagement during disciplinary activity as (a) shared and representative of the collective group norm and (b) multidimensional and synergistic. Study findings suggest that the five dimensions of our PDE rubric are positively interrelated, with high-level engagement across dimensions operating with synergy to explain the joint accomplishment of DE. The case illustration characterizes the interrelated nature of these dimensions for explaining PDE. This work has implications for the evaluation and design of STEM learning environments that integrate collaborative group involvement in disciplinary tasks.

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