

Theorizing and Measuring Collective Productive Disciplinary Engagement

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Abstract: This symposium aims to explore current research working toward conceptualizing and measuring productive disciplinary engagement (PDE) contextualized in diverse learning and project contexts. Disciplinary engagement is critical for fostering students' deep, integrated understanding of STEM content and disciplinary practices. However, there are significant challenges to reaching this engagement quality, with CSCL environments providing opportunities and supports for engagement, but also posing challenges. This symposium aims to account for recent developments, as presenters showcase rich range in exploring application of PDE in diverse domains, grade bands, and learning contexts. The presentations also showcase a range of methods to analyze PDE as collective, situated, cross-contextual, dynamic, and generative.

This symposium aims to explore current research working toward conceptualizing and measuring productive disciplinary engagement (PDE) contextualized in diverse learning and project contexts. This topic is particularly relevant for computer-supported collaborative learning with its focus on coordinating efforts to build shared knowledge with the use of technology support (Roschelle, 2013). Consistent with the theme of the conference, we consider the complex ecosystems of collaborative learning that are embedded within disciplinary ideas and practices. Disciplinary engagement is critical for fostering students' deep, integrated understanding of STEM content and disciplinary practices. Since the early days of reform-based curricula involving inquiry and problem solving, we have been aware that "sustaining the doing, supporting the learning" is necessary to reap the benefits of these challenging learning environments (Blumenfeld et al., 1991). That is, students need to engage in ways that translate their motivations into generative learning with benefits for a greater likelihood of transfer to subsequent educational and professional contexts. There are significant challenges to reaching this deep-level engagement, such as the necessity to coordinate joint activity during cognitively demanding tasks. CSCL environments provide opportunities and supports for engaging in these kinds of tasks, but can also pose challenges (Jeong & Hmelo-Silver, 2016).

We draw from Engle & Conant's (2002) definition of PDE as making collective intellectual progress related to core ideas and disciplinary practices during authentic tasks. PDE exemplifies developments in the learning sciences, including a situative view of engagement, as (1) negotiated and constructed in particular activity systems and (2) comprised of instructional opportunities that support and constrain engagement (Greeno, 2006). This view of engagement significantly extends research which has been grounded in an individual difference paradigm and has been conceptualized as general sense making (e.g., Zimmerman, 1990). Thus, these developments advance engagement as embedded within domain-specific and disciplinary contexts, and central to and inseparable from learning (Gresalfi, et al., 2009). Here, the quality of collective persistence in the face of challenge, positive affect and interest in the ideas and doing of activity, and interpersonal interactions while

making meaningful connections is central to what students come to understand; highlighting the various interdependencies of learning processes, a central aim of CSCL research.

Now 15 years after the introduction of PDE, this symposium aims to present the frontiers of the research and account for developments, as the presentations examine PDE in a range of CSCL environments. We strive to build on a literature which has been limited to a focus on definition within single and illustrative cases to broaden the analytic and empirical landscape. Toward that end, we bring together four research groups showcasing rich range in exploring application of PDE in diverse domains (science, mathematics, engineering, educational psychology), grade bands (middle school through University) and learning contexts (after school programs, inquiry and problem solving curricula, online CSCL, as well as across resources and contexts). The presentations also showcase a range of methods to analyze PDE as collective, situated, cross-contextual, dynamic, and generative. Each presenter will introduce their (1) guiding framework for theorizing collective PDE, as contextualized in particular tasks, domains, instructional settings and disciplinary practices; (2) observable indicators of disciplinary engagement in the collective; and (3) analytic foci, making explicit the affordances of rich analysis for understanding collective engagement. As called for in the CSCL 2019 theme, these varied efforts to foster and study PDE have been carried out in contexts that are intended to support embodied, enactive, extended, and/or embedded CSCL. First, Gresalfi and her colleagues investigate the role of design features, alongside teachers and peers as relational resources, for *jointly* fostering persistence in the face of challenge for children in a computer science camp. Second, Damsa and Palonen consider the interrelationships of engagement dimensions for within and between group interactions during software engineering courses. Using social network analysis alongside qualitative content analysis, they track the change in density and the nature of collaborative engagement, among dimensions, over time. Next, Rogat and colleagues showcase their theoretical framework instantiated in a rubric using quality ratings to examine five dimensions of PDE during collaborative group exchanges, to contrast two case groups during a common collaborative task across two time segments. Subsequently, Hickey and colleagues extend the PDE design framework to be inclusive of expansive framing, by which learners engage with conceptual and disciplinary material in terms of their own personal and cultural orientations within three different undergraduate and graduate online CSCL contexts. Finally, our discussant addresses how these papers have collectively advanced what we understand about PDE within CSCL contexts.

Examining Group Productive Disciplinary Engagement

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This project extends Engle and Conant's (2002) conceptualization of students' productive disciplinary engagement (PDE) by characterizing the shared, multifaceted, and dynamic nature of engagement in the context of collaborative groups. Specifically, this project developed a rubric for describing group PDE in STEM contexts, used to analyze video data and ultimately, as part of real-time classroom observation by researchers and practitioners. The purpose of this work is theoretical development (i.e., specifying this extended definition PDE), as well as methodological development, in order to document patterns of PDE in classroom activities, specifically those that integrate disciplinary content and practices in instruction.

This work draws from and extends two bodies of theoretical and empirical work. First, we draw from engagement research stemming from an individual difference paradigm that conceptualizes engagement as multifaceted, reflective of students' classroom experience, and malleable in context (Fredricks, et al., 2004). A multifaceted conceptualization enables a systematic observation of the dimensions of engagement that make-up PDE, with an eventual goal of examining interrelations and patterns of student engagement towards PDE (i.e., trajectories). Second, we extend prior conceptualizations of PDE (Engle & Conant, 2002). We extend these two paradigms by 1) specifying PDE as a dynamic construct, evolving and devolving over time (Skinner & Pitzer, 2012) and 2) integrating situative perspectives of engagement (Hickey, 2003). Here, a situative view understands engagement as negotiated and constructed in activity systems comprised of instructional opportunities that support and constrain engagement, given curriculum materials, teacher scaffolds, tasks, and interactions among learners (Greeno, 2006). Because PDE reflects students' participation within the social contexts of classroom activity, we extend prior work by providing necessary theoretical specification and methodological approaches to enable a broader analytic focus that encompasses collaborative groups over time. Moreover, our focus on social and disciplinary engagement facets extends extant frameworks aligned with our focus on collaborative groups contextualized in STEM content and disciplinary practices. Here, we aimed to illustrate the affordances of this conceptualization and measurement of collaborative group PDE by examining the changing nature of student

engagement with implications for PDE for two contrasting collaborative groups contextualized in the same curriculum, lesson, domain, and disciplinary context.

Opportunities for and measurement of group PDE are situated in joint collaborative activity. In our work, PDE is contextualized in collaborative tasks involving modeling, design, and argumentation in middle school math, science, and engineering. We draw on a rich corpus of video data collected in 4 projects where group work in these contexts was central to unit goals and what groups came to understand. The range in domain, disciplinary practices and curricular features (e.g., technology tools, scaffolds) has enriched our theoretical development efforts. Data presented here were collected as part of The Promoting Reasoning and Conceptual Change in Science (PRACCIS) project, which developed inquiry-based units to encourage students' scientific reasoning (Chinn et al., 2008). In PRACCIS, collaborative groups develop, evaluate, and revise explanatory models. The video data from the project include filmed class sessions covering three curricular units in two classes from each of four teachers. We present codes of video recordings of two groups collaborating in a lesson occurring later in the curriculum.

The developed rubric encompasses five engagement facets using 3-point quality indicators, these include: *Behavioral engagement* (on-task joint participation); *social engagement* (responsive, equitable coordination), *emotional engagement* (socio-emotional climate), *metacognitive engagement* (shared content, task and disciplinary regulation), and *disciplinary engagement* (integrated conceptual and disciplinary contributions on a larger consequential task), with high-level ratings assumed to promote PDE. The rubric includes a designation of group structure (i.e., pairs; full group), and task characteristics.

Using the developed rubric two coders coded 8 video clips (approximately five-minute segments of each of 2 student groups). Coders achieved inter-coder reliability of 68%, after discussing discrepant codes on 4 clips and then jointly the remaining 4 clips. Codes of the jointly coded 4 video clips are presented here to illustrate the rubric's affordances for studying the dynamic nature of engagement and potential for comparing groups. Analysis of this small set of illustrative codes is visual, based on the presented graphs.

As can be seen in Figure 1, patterns of engagement remain relatively stable across these two, consecutive video segments. Group A exhibits high levels of social and emotional engagement, but do not progress beyond minimal disciplinary engagement. This pattern is a counter-example to common intuition that more social cohesion among groups and positive, emotional engagement, are key contributors to PDE. Similarly, Group B, exhibits a higher form of disciplinary engagement in the second segment, despite the stable and more moderate nature of the other 4 dimensions of engagement, including, social and emotional engagement.

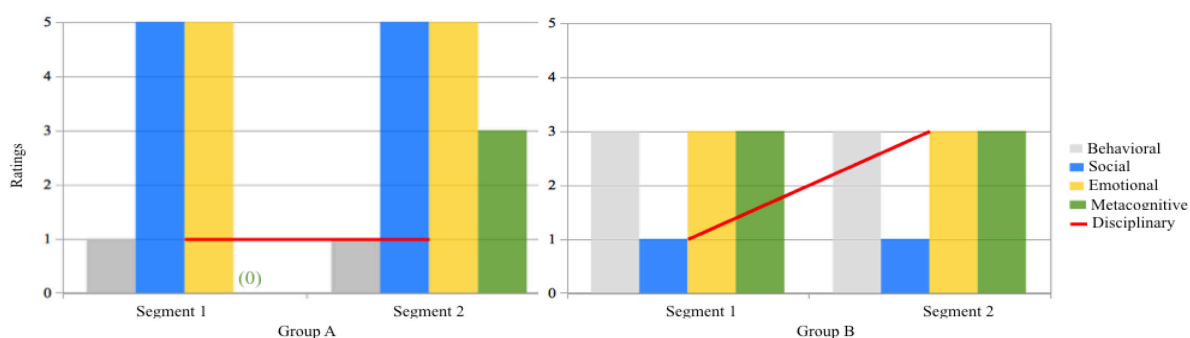


Figure 1. PDE codes of Group A and B across 2 consecutive segments

This small, but illustrative data set highlights the ability of the new rubric to capture the temporal nature of group engagement in STEM practices and, more importantly, to identify patterns of engagement behaviors and their development. When used to code multiple segments of student collaboration, the rubric developed in this project has the potential to document rich patterns that can be examined, identifying how PDE evolves or is disrupted, as a function of group or task characteristics.

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