The Disciplinary Substance of Social Caring

Lara Appleby, Vesal Dini, Lily Withington, Ellise LaMotte, and David Hammer
lara.appleby@tufts.edu, vesal.dini@tufts.edu, lily.withington@tufts.edu, ellise.lamotte@tufts.edu, david.hammer@tufts.edu
Tufts University

Abstract: We analyzed an episode from a course which 11 students took in the summer before their formal matriculation at Tufts, as part of a cohort-based program for engineering majors from underrepresented groups. We also conducted interviews one year later, asking students about their experiences in the course and the program. Based on that data, we argue that two aspects of students' experience contributed to the productive dynamics of the episode and to the lasting value of the course: social caring and a shifted epistemological framing.

> *The philosophic disposition we were working to develop—that of a Socratic thinker who listens deeply […]—was also a disposition towards others.* (Vossoughi, 2011)

Vossoughi (2011) presented an entanglement of intellectual activity and social relationships: Engagement in ideas, "working to make sense of and question" what others are saying, can support and be supported by valuing them as people (i.e., social caring). In this paper, we present evidence of both kinds of engagement (social and intellectual) within a responsively-taught college Physics course run for members of a cohort-based learning community (CBLC). We saw the students doing science in this case, and we invite the reader to consider the potential role, in the students' doing science in this case, for synergy between the two kinds of engagement. Did the social engagement contribute to intellectual engagement? Vice versa? Both?

Background

Cohort-based learning communities

CBLCs, like Meyerhoff and Posse (Maton et al., 2012; Epstein et al., 2015), are designed to support individuals from underrepresented populations in STEM during their undergraduate years through professional development, relationship-building with peers, staff, and faculty, and mentoring, counseling, and tutoring. A major aim of these programs is to promote students' sense of belonging (Strayhorn, 2012, p. 4), which is associated with students' persistence in STEM (Han et al., 2007; Seymour & Hewitt, 1997; Walton & Cohen, 2011).

Disciplinary responsive teaching and inclusion

Disciplinary responsive teaching (DRT) is a discussion-based pedagogy requiring students to hear and deal with diverse reasoning in building their own understanding. It is not explicitly designed for inclusion, and the issue of what needs to happen for DRT to be inclusive is an open one (e.g. Robertson & Atkins-Elliot, 2017).

Doing-science framing

Framing, or one's sense of what's going on in a given situation (Goffman, 1974; Tannen, 1993), for example in school, matters for learning (Scherr & Hammer, 2009). DRT is designed to promote a doing-science framing (Jiménez-Aleixandre et al., 2000), like the one described in the opening quote. There are other possible framings (e.g. doing school) that could be activated by the same students in different situations (Elby & Hammer, 2010), and researchers have been working to understand what supports a given framing—what supports student activation of particular resources for understanding knowledge (e.g. Berland & Hammer, 2012; Dini & Hammer, 2017). For example, a recent study found synergy between affect (about uncertainty) and a doing-science framing (Radoff et al., 2019), showing that a student, "Marya", shifted in her epistemology in a way that supported and was supported by a shift in her affective response to uncertainty. Our argument here is similar in structure: for the students in the CBLC, a shift in epistemology *supported* and *was supported by* their experience of social caring in the course and in the program.

Context and methods

Bridge to Engineering Success at Tufts (BEST) is a CBLC for engineering majors from underrepresented populations and first-generation college students. We analyzed two types of data from a single BEST cohort. The first was a video recording of a class session of Physics 11, which BESTies take the summer before their formal

matriculation at Tufts. This video was part of a larger study to understand which features of an episode of student engagement in disciplinary practices may contribute to that engagement taking place. For that project, the instructor identified a 40-minute segment as such an episode and had it vetted by scientists and science education researchers. We constructed a detailed narrative (Derry et al., 2010) of what took place and applied interaction analysis (Jordan & Henderson, 1995), following the methods of Watkins et al. (2018). For the present paper, we consider a 10-minute portion of that episode, which we call "the case." We also analyzed an interview, conducted one year later, with each member of the cohort. We started each interview by asking to hear anything that students wanted to share about their experiences in science and math courses and BEST in general. Later in the interview, we played a minute-long videoclip from the episode as a prompt for reflections and reactions. We transcribed and summarized each interview, working to capture main themes and include illustrative quotes. We then looked across the summaries for common themes.

Results and analysis

We saw evidence for several contributions to the students' doing science within the case. One such contribution was that the class had established norms of eliciting and focusing on each other's thinking—norms which both support and arise from an epistemological framing that is productive for doing science. This doing-science framing is most clear in participants' apparent relationship to their own and each other's thinking. Participants voice their own thinking even when it apparently conflicts with the thinking of others. This is especially apparent in Mischael's contributions. Participants also treat each other's thinking as sensible and work to bring it into coherence with their own and others, even when that thinking leads to what is known to be a wrong answer. This is especially apparent in Korri's contribution. Participants' work to bring disparate thinking into coherence involves various activities (and activation of various resources) consistent with a doing-science frame. These include invoking intuitive touchstones such as tangible analogies, thinking about the conditional nature of the focal phenomenon (see contributions from Mischael, Kimmee, and Derrick), and connecting physical situations to mathematical concepts such as limits (see Joel's contribution).

In the interviews, we saw additional evidence of the doing-science framing. Also, consistent with what we saw in the case, we heard from every student about friendliness within the class and in general within cohort. These two features—social caring and a productive epistemological framing seemed to interact productively. Here's one student, Yan, describing the interplay between the two features (of a doing-science framing and social caring):

> It wasn't just going into class and he would just write a bunch of stuff on the board, and be like, "Alright, memorize this." It was more like, "Alright, I'm gonna hit this volleyball and this bowling ball with a hammer… What's gonna happen?… What's really happening in the picture?" And everyone has their own thinking, everyone talks a little bit and says, like, "No, I disagree with you," but respectfully. And he lets us talk freely and you realize there's a lotta perspectives in the room. And everyone—they're friendly… And we're kinda just challenging each other.

For Yan, the classroom space is one in which opposing ideas and arguments are welcomed and encouraged, and in which the overall purpose is to generate coherence among the voiced ideas, and which at the same time is "respectful" and "friendly". Below, another student, Adolfo, describes an intra-cohort friendliness which extends beyond class time:

> We had everyone—I had all the other BESTies who were going through the same thing as me, right? They had questions. They're the same questions I did. We all got together. We would do homework. We would interact with each other, make sure we were all doing OK, make sure we were all understanding what was going on… [W]e kinda became a community together, studying together, doing homework together, and we got to know each other really well.

All of the other BESTies expressed a similar kind of closeness with each other, support in academic and extracurricular contexts, and mutual benefit, and described it as developing during the summer program, including within their academic experiences. From these data, we see disciplinary substance of social caring: a theoretical alignment between social caring—caring about each other—and productive epistemological framing—caring about each other's ideas and pursing coherence amongst them.

Discussion and implications

CBLCs and reformed pedagogy, to-date, attend primarily to different forms of belonging: CBLCs focus on helping students feel as though *they* belong in STEM (e.g. Goldman, 2012; Maton et al., 2016), and reformed pedagogy focuses on convincing students that *their ideas and confusions and questions* belong there (e.g. by shifting how students understand and experience what takes place in their STEM classes, their framing (Tannen, 1993), especially as that framing concerns knowledge (Elby & Hammer, 2010)). Based on the data, we conclude that these efforts can support each other: social caring, intentionally fostered by CBLCs, can support productive, shifted epistemologies, and a reformed course that promotes the expression of these epistemologies can serve as a site for the growth of caring social connections. We have evidence that participants in this episode engaged authentically in the pursuit of coherent understanding and grew strong supportive social connections with each other. We suggest that that engagement was supported by an alignment between doing science, which involves attention to arguments, and social caring, which involves intellectual kinship.

Several related approaches to inclusion in K-12 classrooms have emphasized the importance, to student learning, of personal connections with students (e.g. Ladson-Billings, 2009; Gay, 2010; Emdin, 2011). These approaches vary in their way of forming those connections and therefore in the extent to which they align with this case. One core idea of culturally responsive teaching (Gay, 2010), for example, seems to be to shift the content to match the cultural backgrounds of the students. We did not see that kind of matching in this case: course topics were from the conventional curriculum. If there was a cultural matching in this case, we argue that it was because the culture of science that was established within and through the class was inclusive of differences among individuals; at its best, science can be a culture described by Vossoughi as one in which individuals and their ideas are "to be treated with an open and careful spirit, with seriousness as well as critique—in short, with dignity" (Vossoughi, 2011). The case also had some alignment with another inclusive pedagogy, reality pedagogy (e.g. Emdin 2011). One core idea of reality pedagogy seems to be explicitly including students in decision-making about how class is run through out-of-class teacher-student conferences. While responsive teaching does not necessarily explicitly involve students in decision making about how class is run, students in a responsively taught class do affect the content and flow of the class. And in the focal case, several students spoke of how impactful it was to feel some control over the moment-to-moment content of the class.

Overall, through the case, we became aware of deep alignments between DRT and existing approaches to classroom inclusion. Practices in alignment include emphasizing expectations of students' productive resources for learning, the need for students' agency, and teacher listening for and engaging with students' reasoning (see for e.g. Robertson et al., 2015; Ladson-Billings, 2009). By enacting these practices as part of DRT, then, the instructor in this case implemented practices already thought to promote inclusion. We interpret the fact that there was meaningful inclusion in this case as supportive of the idea that these practices can promote inclusion in college science.

Although in this case we considered only at a single cohort, in a single class, we see possible implications of our data and analysis for CBLCs and for college science courses more generally. Maybe institutions with CBLCs can better support the social caring that's at the core of CBLCs theory of change by shifting classroom approaches from those that emphasize instructor explanations to ones that bring out and help coordinate student thinking. And maybe instructors of reformed courses can better support students' productive epistemological framings by attending to emergent social dynamics in their courses, themselves exhibiting and promoting, amongst students, social care. We see the data as highlighting the potential benefits of coordinating these shifts with each other.

References

Berland, L. K., & Hammer, D. (2012). Framing for scientific argumentation. *Journal of Research in Science Teaching, 49*(1), 68-94.

Derry, S. J., Pea, R. D., Barron, B., Engle, R. A., Erickson, F., Goldman, R., Hall, R., Koschmann, T., Lemke, J. Y., Sherin, M. G. & Sherin, B. L. (2010). Conducting video research in the learning sciences: Guidance on selection, analysis, technology, and ethics. *The Journal of the Learning Sciences, 19*(1), 3-53.

Dini, V., & Hammer, D. (2017). Case study of a successful learner's epistemological framings of quantum mechanics. *Physical Review Physics Education Research, 13*(1), 010124.

Elby, A., & Hammer, D. (2010). Epistemological resources and framing: A cognitive framework for helping teachers interpret and respond to their students' epistemologies. In L. D. Bendixen, (Ed.), *Personal epistemology in the classroom: Theory, research, and implications for practice* (pp. 409-434).

Emdin, C. (2011). Moving beyond the boat without a paddle: Reality pedagogy, Black youth, and urban science education. *The Journal of Negro Education, 80*(3), 284-295.

Epstein, I., Godsoe, K., & Kosinski-Collins, M. (2015). The Brandeis Science Posse: Using the Group Model to Retain Students in the Sciences. *Athens Journal of Education, 2*(1), 9-21.
Gay, G. (2010). *Culturally Responsive Teaching: Theory, research, and Practice*. Teachers College Press.
Goffman, E. (1974). *Frame analysis: An essay on the organization of experience*. Harvard University Press.
Goldman, C. A. (2012). A cohort-based learning community enhances academic success and satisfaction with University Experience for First-Year Students. *The Canadian Journal for the Scholarship of Teaching and Learning,* 3(2).
Han, J., Sax, L., & Kim, K. (2007). Having the talk: engaging engineering students in discussions on gender and inequity. *Journal of Women and Minorities in Science and Engineering, 13*(2), 145-163.
Jiménez-Aleixandre, M. P., Bugallo Rodríguez, A., & Duschl, R. A. (2000). "Doing the lesson" or "doing science": Argument in high school genetics. *Science Education, 84*(6), 757-792.
Jordan, B., & Henderson, A. (1995). Interaction analysis: Foundations and practice. *The Journal of the Learning Sciences, 4*(1), 39-103.
Ladson-Billings, G. (2009). *The dreamkeepers: Successful teachers of African American children*. John Wiley & Sons.
Maton, K. I., Beason, T. S., Godsay, S., Sto Domingo, M. R., Bailey, T. C., Sun, S., & Hrabowski, F. A., 3rd (2016). Outcomes and Processes in the Meyerhoff Scholars Program: STEM PhD Completion, Sense of Community, Perceived Program Benefit, Science Identity, and Research Self-Efficacy. *CBE Life Sciences Education*, *15*(3), ar48.
Maton, K. I., Pollard, S. A., McDougall Weise, T. V., & Hrabowski, F. A. (2012). Meyerhoff Scholars Program: A strengths-based, institution-wide approach to increasing diversity in science, technology, engineering, and mathematics. *Mount Sinai Journal of Medicine: A Journal of Translational and Personalized Medicine, 79*(5), 610-623.
Radoff, J., Jaber, L. Z., & Hammer, D. (2019) "It's scary but it's also exciting": Evidence of meta-affective learning in science. *Cognition and Instruction 37*(1), 73-92.
Robertson, A. D., & Atkins-Elliott, L. J. (2017). "All Students are Brilliant": A Confession of Injustice and a Call to Action. *The Physics Teacher*, *55*(9), 519-523.
Robertson, A. D., Scherr, R., & Hammer, D. (2015). *Responsive Teaching in Science and Mathematics*. Routledge.
Scherr, R. E., & Hammer, D. (2009). Student behavior and epistemological framing: Examples from collaborative active-learning activities in physics. *Cognition and Instruction*, *27*(2), 147-174.
Seymour, E., & Hewitt, N. M. (1997). *Talking about leaving: Why undergraduates leave the sciences*. Westview.
Strayhorn, T. L. (2012). *College students' sense of belonging: a key to educational success for all students*. Routledge.
Tannen, D., Ed. (1993). *Framing in discourse*. Oxford University Press on Demand.
Walton, G. M., & Cohen, G. L. (2011). A brief social-belonging intervention improves academic and health outcomes of minority students. *Science, 331*(6023), 1447–1451.
Watkins, J., Hammer, D., Radoff, J., Jaber, L. Z., & Phillips, A. M. (2018). Positioning as not-understanding: The value of showing uncertainty for engaging in science. *Journal of Research in Science Teaching*, *55*(4), 573-599.
Vossoughi, S. (2011). On the formation of intellectual kinship: A qualitative case study of literacy, learning, and social analysis in a summer migrant education program. University of California, Los Angeles.

Acknowledgments

This work was supported in part by Gordon and Betty Moore Foundation Grant No. GBMF3475 and a grant to Tufts University from the Howard Hughes Medical Institute through the Science Education Program. Thanks to the team of professional scientists at Tufts for their perspectives on episodes of students doing science. Thanks also to Campbell Halligan and Courtney Russo, the institutional heart and soul of BEST. Most of all, thanks to the 2021 BEST cohort for sharing what it was like to simultaneously leave home, make friends, and learn physics.