2021 ASEE ANNUAL CONFERENCE
Virtual Meeting | July 26–29, 2021 | Pacific Daylight Time
Paper ID #34277

Revolution in CBEE: Connecting the Dots between Inclusivity and Learning

Dr. Milo Koretsky, Oregon State University

Milo Koretsky is the McDonnell Family Bridge Professor in the Department of Chemical and Biological Engineering and in the Department of Education at Tufts University. He received his B.S. and M.S. degrees from UC San Diego and his Ph.D. from UC Berkeley, all in Chemical Engineering. He currently has research activity in areas related engineering education and is interested in integrating technology into effective educational practices and in promoting the use of higher-level cognitive skills in engineering problem solving. His research interests particularly focus on what prevents students from being able to integrate and extend the knowledge developed in specific courses in the core curriculum to the more complex, authentic problems and projects they face as professionals.

Dr. Susan Bobbitt Nolen, University of Washington

Professor Emerita of Learning Sciences and Human Development, Dr. Nolen's work focuses on engagement and learning from a situative perspective. Recent research at the postsecondary level includes the take-up and use of tools for concept-based instruction in mechanical engineering and engagement and negotiation in group work on simulated real-world problems in engineering.

Michelle Kay Bothwell, Oregon State University

Michelle Bothwell is a Professor of Bioengineering at Oregon State University. Her teaching and research bridge ethics, social justice and engineering with the aim of cultivating an inclusive and socially just engineering profession.

Dr. Christine Kelly, Oregon State University

Dr. Kelly earned her BS in Chemical Engineering from the University of Arizona and her PhD in Chemical Engineering from the University of Tennessee. She served as an Assistant Professor for 6 years at Syracuse University, and has been an Associate Professor at Oregon State University in the School of Chemical, Biological and Environmental Engineering since 2004, where she also served for three and half years as the Associate Dean for Academic and Student Affairs of the College of Engineering.

Dr. Susannah C. Davis, University of New Mexico

Susannah C. Davis is a research assistant professor at the University of New Mexico. She holds a Ph.D. and M.Ed. from the University of Washington and a B.A. from Smith College. Her research explores how postsecondary institutions, their faculty, and their administrative leaders navigate organizational change and reform efforts and learn in the process. Her current research focuses on how institutions of higher education create more equitable and inclusive policies, practices, and climates, as well as how systems of power shape reform efforts.

Revolution in CBEE:
Connecting the dots between inclusivity and learning

1. Overview

Supported by an NSF RED grant, the School of Chemical, Biological, and Environmental Engineering (CBEE) at Oregon State University seeks to create: (1) a culture where everyone in the CBEE community feels a sense of value and belonging, and (2) a learning environment that prompts students and faculty to meaningfully relate curricular and co-curricular activities and experiences to each other and to connect both with professional practice. For brevity, we label the first goal "equity and inclusivity" and the second "meaningful, consequential learning." In this paper, we encapsulate our work in this last year (no cost extension) of the grant through the lens of our 17 published or in preparation journal articles.

Our research in equity and inclusivity has had three foci: student climate, conceptualization of oppression and privilege, and organizational change. This research has addressed themes of peer relations, the relation between epistemology and climate, assessment metrics for understanding systems of power, reflection on problematic norms that frame engineering culture, and uncontested informal *practices* that produce gendered and racialized inequities across the institution. Our research in meaningful, consequential learning has focused on activities and assessments that align schooling and engineering practice, and on active learning in studios. As we worked on this project, the team created a shared understanding that equity and inclusivity and meaningful, consequential learning are not separate issues but rather mutually constitutive, as theorized for science education (Windschitl & Baron, 2016) and engineering education (Koretsky et al., 2018), where we have described four guiding principles. We illustrate this interplay around aspects of inclusive teaming. We are building on these principles to provide a theoretical framework in the in-preparation manuscript **"**Inclusive Excellence in Practice: Leveraging Synergies Between Inclusivity and Student Learning Goals in Higher Education."

We address the important synergies between learning and equity goals in higher education through a systems-oriented framework and approach that integrates equity and inclusivity with meaningful, consequential learning (Figure 1). Our entire efforts on the project can be described as investigating these two complementary themes and the interplay between them. Under the

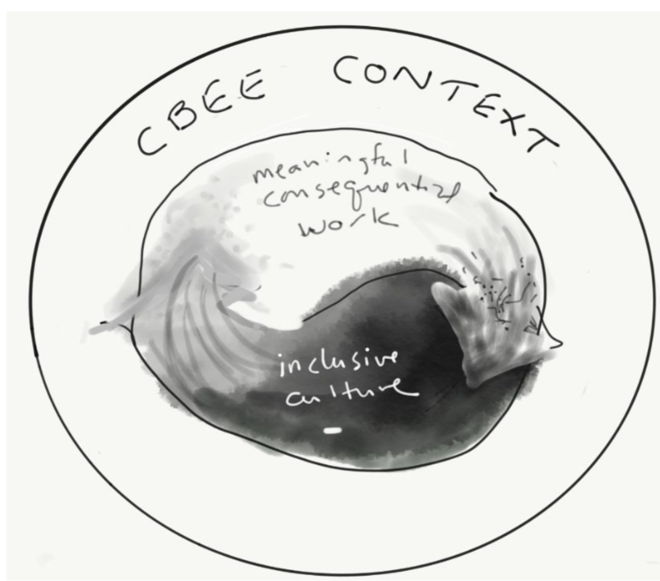

Figure 1. Revolution in CBEE; Mutually constitutive aspects of the organizational change project

theme of meaningful and consequential learning we have investigated (a) curricular structures and (b) activities and assessments that align schooling and engineering practice. Within the theme of equity and inclusivity we have studied (a) student climate, (b) conceptualization of oppression and privilege, and (c) organizational change. These studies have revealed that peers and teams unite the themes of meaningful and consequential learning and equity and inclusion.

2. Meaningful and consequential learning

Our focus of curriculum reform has been towards shifting activity to meaningful, consequential learning in activity-based studio and laboratory courses to better prepare students to connect the knowledge they are learning in school to the messy, open-ended work they will encounter as practicing engineers (NAE, 2020). Meaningful, consequential learning centers on work that positions students on teams in the role of engineers where they need to identify core foundational principles as conceptual tools to progress (Johri & Olds, 2011). We draw upon Engle and Conant's (2002) productive disciplinary engagement to describe engineering students' use of concepts, practices, and discourses of engineering to "get somewhere" (develop a process or product, gain better understanding) over time. We describe this approach in more detail in Koretsky et al. (2015, 2018).

The theoretical framework that guides our approach to learning rests in social practice theory (Bourdieu, 1977; Holland et al., 1998; Lave & Wenger, 2001). We use activity systems (Engstrom, 2001) to study and explicate the interconnected network of rules and tools which students use to complete their objective of *doing school* (Boaler & Greeno, 2000). In activity theory, the social rules embedded in the classroom lead to a set of ingrained behaviors, values, and actions in both students and instructors. Understanding how students engage in learning practices relative to CBEE's activity system is critical in developing strategies for change. We also use Holland and colleagues' (1998) identity theory of "figured worlds" that describes ways that individuals develop identities, such as student or as engineer, through participation in activity. In this section, we present a summary of grant-related progress in terms of curricular structures and activities and assessments that align with engineering practice.

2.1 Curricular structures

Our design-based implementation research approach (Koretsky et al., 2018) involves a continually interacting set of components, including: theory, implementation and data collection, and analysis and interpretation. We focus on how the threads of identity, academic success, and professional formation in the core chemical engineering curriculum can be intentionally interwoven to form a network of practices that fosters both student achievement and diversity, inclusivity and social justice. In conceptualizing the figured worlds of "school world" and "engineering world," we accounted for features that unjustly and unintentionally *exclude* some people from engineering. This work has led to four guiding principles:

[1] Increasing inclusivity, diversity, and social justice requires shifts in the CBEE culture that affect the experiences and expectations of students and faculty to increase the degree to which diverse individuals **identify as engineers.**

[2] Organized cultural change leads to inclusion when it reflects and affirms the lived experiences of all members of the community as people with complex, **multifaceted identities**.
[3] These changes should align with our community's core shared mission of developing students' engineering **knowledge and skills.**
[4] Explicit pedagogical and social supports for students and faculty will help to transition their identities, knowledge, and skills **from school world to engineering world**.

While developing and improving innovative course activities is critical for advancing student-centered and socially just learning goals, faculty are provided little time to innovate and are not appropriately evaluated or rewarded for these efforts. In Davis et al. (in preparation A), we examine faculty's experiences with a new collaborative teaching structure that we call Alternating Leads. In Alternating Leads, pairs of faculty are assigned to particular courses. In principle, each year, one member of the pair is the lead instructor while the other has more capacity to work on innovative activity development and student support. The next year the members of the pair switch roles. However, recognizing the pair is faced with other curricular and professional constraints, we allowed a large amount of autonomy for them to define their collaborative policies and practices. This model is designed to provide faculty with time and support for ongoing, progressive course development; facilitate vertical integration efforts; free up faculty time for more interactions with students by being more efficient with logistical, technology, and delivery processes; and model the collaborative and inclusive teaming behaviors we seek to develop in students.

We piloted implementation of the Alternating Leads structure with 15 faculty in eight courses (six studio courses and two lab courses) over four academic quarters. Using interview data from instructors and administrators, we investigate the benefits and challenges of implementing different models of co-teaching, including Alternating Leads. We use cultural-historical activity theory (CHAT) to examine how tensions within and among the unit's policies, practices, values, and norms affected faculty's experiences and the overall implementation of different manifestations of Alternating Leads. Findings suggest that in order to realize the goals of co-teaching related to student and faculty development, the department and its members should develop a shared vision and shared values around co-teaching. Such a shared vision requires the community to confront some important implicit assumptions about teaching practice and what is rewarded.

2.2 Activities and assessments that align schooling and engineering practice

To unpack the elements of the CBEE activity system that influences students' adoption of more or less productive approaches to learning, we report a qualitative study where we used thematic analysis of the written reflections of one hundred and eighty engineering students (Michor and Koretsky, 2020). We report two major findings. First, by far, the most common elements that prompt students to activate either rote or conceptual approaches was the assignments and assessments they were required to complete. Thus, the type of work students are assigned is critically important in developing productive engagement. For example, for student-centered classroom practices (e.g. active learning) to effectively elicit conceptual thinking, there must be corresponding shifts in the homework, projects, and tests within a course. Second, student responses citing overall activity system elements, such as time constraints and the importance of grades, while less frequent, almost always prompted rote learning. Importantly, they often contained language of inevitability and despair. This study has been influential in prompting us to think about ways students engage in the work we assign, and how to shift that work to be more meaningful and consequential.

For example, using the methodological framework of design-based research, we report on a two-stage exam with authentic assessment in an effort to align classroom assessment with engineering practice (Koretsky et al., in review). Two stage exams are gaining popularity as a large-class assessment practice (Efu, 2019; Rieger & Heiner, 2014). The first stage is a traditional individual assessment. In the second stage, students work collaboratively in teams. In our modification, rather than having students answer the same questions as the individual portion, we provide an authentic engineering task that is supported by a virtual laboratory that we developed. The task placed students on teams in the role of engineers needing to negotiate uncertainty as they make decisions. Analysis of data from one-hundred seventeen teams across two classes showed that the teams chose many different solution paths that corresponded to needing to make engineering decisions. Since the technology enabled us to track each team's individual data, we were also able to determine the accuracy of most teams' calculations once their decision path was determined. Students showed differing responses to this form of assessment with some valuing the authentic nature and others' struggling with shifts in the rules and norms for assessment.

Several papers focus on innovative ways to shift class activities to align with professional practices. Data and measurement form a core element of engineering practice. Correspondingly, we have implemented a series of virtual laboratories to complement the physical laboratories in our program in a way that is manageable within the constraints of a large land-grant university. Several studies examined the implementation and student engagement, comparing virtual and physical laboratory projects. In Hirshfield and Koretsky (2020), we look at elements of creativity by analyzing student teams' solution paths and comparing elements of divergent thinking in virtual and physical laboratory projects and comparing students to experts. We found that teams showed greater fluency, flexibility, and originality in the virtual laboratory project than in the physical laboratory projects, but there was little difference between student teams and experts.

In Koretsky et al. (in review), through analysis of student laboratory notebooks and post-project presentations, we examine the modeling practices of teams as they need to use laboratory data to develop a design recommendation. Using a novel analytical tool that we developed, Model Maps, we found a greater number and diversity of model components of twenty-nine teams in the virtual laboratory project as compared to two physical laboratory projects. We argue that in the virtual laboratory project that we developed, student teams had the opportunity to better engage in interlocking conceptual and material aspects of engineering practice. Finally, in Koretsky (2020), we show how one of the Interactive Virtual Laboratories that we use in studio allowed students to make meaning of the difference between reaction rate and equilibrium by exploring their dependence on temperature. We have also reported on the influence of COVID necessitated remote teaching on student learning practices in a studio course (Koretsky, 2020).

We have also used activity theory to examine co-curricular engagement in engineering clubs (Hinkle and Koretsky, 2019). This interview-based study sought to characterize and compare the activity systems of a domestic chemical reaction car competition, a formula racing club that competes both domestically and internationally, and a humanitarian engineering club centered on service learning projects in developing countries. Through analysis of club observations (27 sessions) and semi-structured interviews with 19 participants we identified a confluence of elements, especially decision-making rules and division of labor, leads to a fundamentally distinct culture in each club. We argue that students' professional formation is influenced by the social rules and structures as much as by the specific work that is being done – although the two are related.

3. Equity, inclusivity, and social justice

Our efforts to foster inclusive and equitable education programs and workplace environments have included curricular development initiatives at both the graduate and undergraduate levels, as well as interventions to shift unit- and college-level policies and practices towards those that are more socially just. Here, we report recent, relevant research initiatives that have informed and supported this work. These will be discussed below, organized around the broad topics of (i) student climate; (ii) conceptualization of oppression and privilege; and (ii) organizational change.

3.1 Student climate

We report on a survey study of undergraduate students in a multi-program engineering department assessing perceptions of departmental and campus climate (Davis et al., in review). Structural equation modeling results indicated widespread perception of the department as more welcoming for White, male and US-born students than for students with any of the other remaining identities. Perceptions of climate were related negatively to reports of bias and positively to perceived faculty support and safety. Positive peer relations were strongly positively related to engineering identity; microaggressions weakly negatively related. Students wished for more diverse and inclusive faculty and found peer relations while working in groups to be particularly important to their identification with their disciplines.

This survey study was augmented by a qualitative study that involved sixteen focus groups and six individual interviews in the exploration of undergraduate engineering students' perceptions of their sense of belonging in their engineering program, particularly as these related to their social identities (Godbole et al., 2018). Similar to the quantitative results, students who identify along dominant social identity categories experienced a strong sense of belonging. Of this group, about half are unaware of the unearned advantages linked to their social position, while the other half articulate an understanding of their privilege. International students and students of color generally expressed a lower sense of belonging in the unit and had a high perception of privilege, power and oppression. While most students expressed a general sense of gender parity within CBEE many described personal experiences that point to gender inequity within the unit. This may be due in part to the current emphasis placed on the diversification of the engineering profession over concepts of inclusion, equity and social justice.

3.2 Conceptualization of oppression and privilege

Part of our reform initiatives in the unit involved education opportunities designed to enhance both students' and faculty's capacities to engage issues of inclusivity, equity and social justice. An assessment tool to measure a person's conceptualization of oppression and privilege was needed in order to monitor the effectiveness of the learning opportunities. While there were quantitative assessment instruments that measure constructs such as "cultural competencies," we were not aware of any that measure understanding of social power and oppression. In Johnson et al. (in preparation), we describe a qualitative instrument designed to do the latter. Our approach builds on conceptual change research in engineering and the physical sciences where a student's understanding of ill-structured problems is investigated through semi-structured interviews. In our research, we developed a realistic and relatable vignette centered on gender dynamics that explores four broad themes of understanding: social construction of gender and masculinity, systems of power, gender roles, and cooptation and power dynamics. The instrument was piloted with eight faculty and eight students, with responses evaluated along five spectrums of conceptual understanding of oppression and privilege: the social construction of gender and masculinity, systems-framing, including the identification of institutions that maintain and reproduce social hierarchies, intersectional analysis, and appropriate use of relevant vocabulary. The knowledge and understanding of the sixteen participants were spread fairly evenly across each of the five scales, with some demonstrating little to no grounding in systems of oppression while others demonstrated high competency.

We use the lens of epistemology to propose a way of talking about the philosophical issues that are most relevant to issues of systemic oppression in engineering education (Montfort, in preparation). Some common (in engineering) assumptions about knowledge and expertise play a central role in supporting oppressive and hierarchical structures in engineering education. We propose a model of epistemological change based on cognitive science and DBER research on conceptual change. Rather than critiquing some epistemologies, we use the language and processes of conceptual change to encourage reflection and productive discussion of epistemological issues such as expertise and authority and problem-solving in uncertain conditions. We then provide examples of the important implication of epistemological discussion in the context of social justice reform in engineering education, and in relation to research on the culture of engineering.

3.3 Organizational change

Our approach to organizational change centers the cultural and social processes and structures that can promote or inhibit change in our setting. This approach has great potential value in the ways it can surface unseen issues that limit the effectiveness of reform efforts. In this vein, we have identified the relevant norms in engineering education that are incompatible with student-centered, social justice reform. Norms are the often unspoken assumptions and expectations that shape our interactions by defining what is "normal" or "natural." For example, there is often a strong association between faculty and the courses they teach – in many cases courses are treated as the property or domain of the faculty member that teaches them. While neither positive or negative on its own, the norm exerts a subtle pressure against collaborative or program-level reform efforts. Discussing this norm makes space to imagine alternatives and to help the community adapt to changes.

We have been engaged in two parallel, synergistic programs (NSF RED and ADVANCE) aimed to shift organizational practices and structures towards those that are more equitable and socially just. Both projects are nearing their ends, and assessment and evaluation indicate our interventions have been effective in advancing structural changes that lead to women and marginalized groups' greater participation and advancement in STEM. The projects have been particularly effective at shifting formal policies towards those that are more equitable, inclusive and socially just. At the same time, however, in an autobiographical analysis (Bothwell & Plaza, in preparation), we describe personal experiences that point to deeply embedded, uncontested informal *practices* that produce gendered and racialized inequities across the institution, including: (i) conducting internal searches for administrative vacancies or skipping searches altogether and hand-picking new administrators through "waivers of search"; (ii) disproportionately providing lateral prestigious shifts or very soft parachute landings for white Euro-American men who are stepping out of senior administrative roles (compared to women or people of color in those same positions); and (iii) engaging in negotiations with potential faculty recruits or Oregon State employees that result in differential access to resources and opportunity structures along gendered and racialized lines. These problematic practices are presented through three composite case studies with analysis focused on decision points and behavior choices engaged by those involved in the case that lead to gendered and racialized inequities.

4. Peers and teams – uniting themes

As shown in Figure 1 (page 1), we have learned that meaningful, consequential learning and equity, inclusion, and social justice interact – both at the classroom level and at the department level (Davis et al., in preparation B). We have pursued these interactions in the context of the relational work students do with other students and instructors to learn engineering. Because engineering work relies on effective collaboration and communication among diverse groups of engineers and scientists engaging in partnership with broader constituencies (managers, technicians, end users, among others), advancing students' knowledge and skills needed for effective and inclusive teamwork provided one platform where these interactions readily emerged.

When engineering students graduate, they leave the world of engineering school to enter the "real" world of engineering. The practices of successful students, however, experienced in the approaches to structured, abstract "book problems," do not necessarily translate into those needed by practicing engineers. Part of the RED change effort has focused on providing better opportunities for students to engage in meaningful engineering work in school, leveraging existing "studio course" structures to shift thinking from a "school-world" focus on correct answers to an "engineering world" focus on multiple possible paths to meeting engineering objectives. A primary means for this effort is developing studio tasks which encourage students to "think like engineers" through design tasks situated in simulated "real-world" engineering contexts (Studio 2.0 tasks). This contrasts with the more decontextualized, structured and abstract tasks typical of school problems (Studio 1.0 tasks).

In a laboratory study (Nolen et al., in preparation), we analyzed the interactions of teams of advanced undergraduate engineering students as they worked to address a Studio 2.0 task. We were interested in how students who had been successful doing typical engineering school (1.0) work would negotiate their approach to this novel kind of task. We found evidence of both "school world" and "engineering world" approaches across and within teams. We identified characteristic objectives and practices for each world and examined the circumstances under which groups shifted from one world to the other. All groups we studied spent at least some time engaging in engineering world but often needed significant time and negotiation to shift from familiar but unsuccessful approaches to "thinking like engineers." Our analysis of the shift process, including the role of power dynamics within groups, should be useful to instructors who wish to provide more meaningful opportunities for engineering thinking in school.

From 2017-2019, postdoctoral researchers, instructors, and tenure-lined faculty primarily from our unit, engaged in a Practitioner Learning Community (PLC) focused on the design of instructional content, pedagogy, and assessment metrics for productive, inclusive and socially just teaming practices. The PLC was thoughtfully designed to include practices known to produce sustainable instructional shifts. The PLC members developed and piloted processes for team norming, curricula for functional teaming (e.g., conflict management and effective communication), modules to engage students in the examination of systems and ideologies that sustain inequities in the practice of engineering, and assessment instruments to measure student teaming competencies (Lutz et al., 2019).

The development of students' teamwork skills is a key goal of engineering education programs. Measuring teamwork skills, or "an ability to function effectively on a team…" as it is worded in the ABET student outcomes, is not straightforward. The outcomes of "good" teamwork are well understood, but it is much more complicated to identify and assess the development of the skills that lead to those outcomes. In Mallette et al. (in preparation), we investigate students' and faculty members' conceptions of teamwork as a way to begin to frame the assessment of teamwork skills in this community using in-class surveys for a variety of teamwork-based senior courses. Hundreds of individual student reflections were analyzed thematically to identify common patterns and themes in the students' understanding of teamwork. Students expressed strong preference for specific methods of facilitating teamwork, for example preferring that they be allowed to choose their own teammates, or, if not, then to have teammates assigned based on schedule similarities so that meetings were easier to arrange. Patterns in student preferences suggest that they view teamwork through the lens of the educational experience: they view it as an additional type of assigned work that is added-on to big projects in many courses. They are frustrated by the logistical challenges of sharing time, space and work, and feel that much of the success or failure of teamwork depends on personalities and is therefore largely out of their control. Teamwork skills are viewed as last-ditch ameliorative efforts for failing teams. In contrast, the instructors of these courses (who are also the authors of this paper) view teamwork as productive method of achieving goals (not just more work). We are also frustrated by the challenges of organizing teamwork, but we are strongly committed to the idea that teamwork is an ongoing skillful process that can be managed well through practice and reflection. The differences between faculty and student views of teamwork suggest a starting place for pedagogical development: students are often required to be in teams, rather than encouraged to make use of them. Direct instruction about teamwork processes (e.g. team contracts for norm and goal setting, empathetic listening for conflict management) that is followed up with opportunities to practice those processes and finally assessment (or reflection) could help to motivate students to engage with teamwork as a resource. Additionally, there are aspects of the students' perspective that faculty could adopt to improve mutual understanding. The survey responses show students as willing partners ready to engage the functional work of organizing and facilitating teamwork. They made requests and suggestions freely, and often requested that teamwork skills be practiced more frequently and earlier in the curriculum. Especially in large-enrollment courses, students could be enlisted to help with the logistics of team forming and management. Finally, both student and faculty perspectives repeatedly refer to the central challenging fact about teamwork: human and social interactions are complex, chaotic and context-bound.

Finally, connected to the teamwork perceptions to the laboratory study, we propose that students will be more motivated to learn teaming skills if they are meaningful and consequential. When teams operate in school world, the single high-status student tends to direct the work. Thus, school world engagement makes teaming an add-on chore and a burden. As the work shifts to the creative, uncertain, and temporally emergent work in engineering world, multiple perspectives become useful, and even necessary to make meaningful progress. In this mode of engagement, teammates become resources and teaming skills are valued.

Acknowledgements
The authors are very grateful for the interest and participation in our work from so many members of our School community – students, staff, and faculty. We also acknowledge the support provided by the National Science Foundation through grant EEC 1519467. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

Boaler, J., & Greeno, J. G. (2000). Identity, agency, and knowing in mathematics worlds. *Multiple perspectives on mathematics teaching and learning*, *1*, 171-200.

Bourdieu, P. (1977). *Outline of a Theory of Practice.* Cambridge university press.

Bothwell, M. K., & Plaza, D. (in preparation). Sweetheart Deals: informal promotion practices that produce gendered and racialized workplace inequities in higher education, *ADVANCE Journal*.

Davis, S., Nolen, S., Cheon, N., Moise E., & Hamilton E. (in review). Engineering Climate for Marginalized Groups: Connections to Peer Relations and Engineering Identity.

Davis, S., Nolen, S, & Koretsky M. (in preparation A). Shifting Instructional Practices through Co-teaching: A CHAT Analysis of Organizational Learning

Davis, S., Nolen, S, & Koretsky M. (in preparation B). Inclusive Excellence: Synergies Between Equity and Student Learning in Practice

Efu, S. I. (2019). Exams as learning tools: A comparison of traditional and collaborative assessment in higher education. *College teaching*, *67*(1), 73-83.

Engeström, Y. (2001). Expansive learning at work: Toward an activity theoretical reconceptualization. *Journal of Education and Work*, 14(1), 133-156.

Engle, R.A., & Conant, F.R. (2002). Guiding principles for fostering productive disciplinary engagement: Explaining an emergent argument in a community of learners classroom. *Cognition and Instruction*, 20(4), 399-483.

Godbole, A., Miller, B., Bothwell, M. K., Montfort, D., & Davis, S. C. (2018, April), *Engineering Students' Perceptions of Belonging through the Lens of Social Identity* Paper presented at 2018 CoNECD - The Collaborative Network for Engineering and Computing Diversity Conference, Crystal City, Virginia. https://peer.asee.org/29530

Hinkle, C. M., & Koretsky, M. D. (2019). Toward professional practice: student learning opportunities through participation in engineering clubs. *European Journal of Engineering Education*, *44*(6), 906-922.

Hirshfield, L. J., & Koretsky, M. D. (2021). Cultivating creative thinking in engineering student teams: Can a computer-mediated virtual laboratory help?. *Journal of Computer Assisted Learning*. 37, 587-601

Holland, D., Lachiocotte, W., Skinner, D., & Cain, C. (1998). *Identity and Agency in Cultural Worlds*, Cambridge, MA: Harvard University Press.

Johnson, R. M., Wells, J. R., Bothwell, M. K., Montfort, D., & Furman, K. (in preparation). Measuring the Conceptualization of Oppression and Privilege.

Johri, A. & Olds, B.M. (2011) Situated engineering learning: Bridging engineering education research and the learning sciences. *Journal of Engineering Education*, 100(1), 151-185.

Koretsky M.D. (2015). Program level curriculum reform at scale: Using studios to flip the classroom. *Chemical Engineering Education*, 49(1), 47-57.
Koretsky, M. D. (2020). An interactive virtual laboratory addressing student difficulty in differentiating between chemical reaction kinetics and equilibrium. *Computer Applications in Engineering Education*, *28*(1), 105-116.
Koretsky, M. D. (2020). Re-flipping in the Remote Classroom: The Surprising Uptake of Video-Recorded Worked Examples. *Journal of Chemical Education*, *97*(9), 2754-2759.
Koretsky, M., Montfort, D., Nolen, S. B., Bothwell, M., Davis, S., & Sweeney, J. (2018). Towards a stronger covalent bond: pedagogical change for inclusivity and equity. *Chemical Engineering Education*, *52*(2), 117-127.
Koretsky, M.D., McColley, C.J., Gugel, J.L., & Ekstedt T.W. (in review). Aligning Classroom Assessment with Engineering Practice: A Design-Based Research Study of a Two-Stage Exam with Authentic Assessment.
Koretsky, M., Nefcy, E. Nolen, S., & Champagne, A. (in review). Designing engineering tasks for real university settings: Model use in physical and virtual laboratory-based design projects.
Lave, J., & Wenger, E. (1991). Situated learning: Legitimate peripheral participation. Cambridge university press.
Lutz, B. D., Bothwell, M. K., AuYeung, N., Carlisle, T. K., Mallette, N., & Davis, S. C. (2019, April), Practitioner Learning Community: Design of Instructional Content, Pedagogy, and Assessment Metrics for Inclusive and Socially Just Teaming Practices Paper presented at 2019 CoNECD - The Collaborative Network for Engineering and Computing Diversity , Crystal City, Virginia. https://peer.asee.org/31781
Mallette, N., Wells J., Kelly C., & Montfort, D. (in preparation). Student experiences of vertically integrated teamwork pedagogy.
Montfort, D. (in preparation). Epistemological underpinnings of social justice in engineering.
NAE (2020) National Academy of Engineering, Educating the Engineer of 2020: Adapting Engineering Education to the New Century. Washington, DC: National Academies Press, 2005.'
Nolen, S., Michor, E., & Koretsky M. (in preparation). Engineers, Figuring it out: Collaborative Learning in Cultural Worlds.
Rieger, G. W., & Heiner, C. E. (2014). Examinations that support collaborative learning: The students' perspective. *Journal of College Science Teaching*, *43*(4), 41-47.
Windschitl, M., & Calabrese Barton, A. (2016). Rigor and equity by design: Locating a set of core teaching practices for the science education community. *Handbook of research on teaching*, 1099-1158.