A preliminary case study on the impact of the cultural narratives of individualism, meritocracy, and rigor on collaboration

Alexander Conte (he/him)
Department of Teaching & Learning, Policy & Leadership, University of Maryland, College Park, Maryland, 20742

Erin Sohr (she/her), Jennifer Radoff (she/her)
Department of Physics , University of Maryland, College Park, Maryland, 20742

Andy Elby (he/him)
Department of Teaching & Learning, Policy & Leadership, University of Maryland, College Park, Maryland, 20742

Students are encouraged to work with their peers more than ever as physics and engineering instructors come to appreciate that collaboration can support student learning. However, many factors within and outside these collaborative spaces influence students' decisions to collaborate or to seek help in other ways, like accessing online homework solutions. To investigate how students navigate these decisions and why, we interviewed and collected audio recordings of autoethnographic reflections from undergraduate engineering students taking physics courses. We present a preliminary analysis of "Ashley's" decision making. She is an Engineering and Music double major who splits her time between coursework, band practice, and social events on campus. She tends to avoid collaboration outside of class, and she is an unapologetic user of Chegg, a paid online service that provides solutions to problems that students submit. We explore how various factors such as cultural narratives, disciplinary identity, and individual personality traits combine to push Ashley toward favoring Chegg over peer collaboration when seeking help with her engineering coursework. This line of research can inform instructional interventions aimed at supporting collaboration and discouraging unproductive solutions-use.

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I. INTRODUCTION

Given the centrality of collaboration as a professional practice within engineering and given that students often need support in getting through their engineering coursework, we might expect students to rely on each other for help. Collaboration, after all, helps to facilitate student learning and engagement [1,2]. Also, many engineering courses, including "Ashley's," include dedicated class sessions for students to work on problems together or assign group projects as exam alternatives. In light of all this messaging and scaffolding in support of collaboration, why doesn't Ashley rely more on collaboration?

Previous research on reasons students' don't participate in group work (or otherwise collaborate) outside of class include (i) marginalization because of their racial, gender, and sexual identities [3,4,5], (ii) individual personality traits or preferences [6,7], and (iii) cultural and structural aspects of engineering programs [8]. Often, a given research study focuses on one or two of these categories or factors. We claim that Ashley's decision-making about collaboration stems from a complex combination of multiple interacting factors: she internalizes certain cultural narratives present within engineering and contends with her own engineering and personal identities. This internalization of aspects of engineering culture is ever present in Ashley's decision-making that almost always leads her to use online solutions (like Chegg) before—and usually instead of—reaching out to a peer for assistance.

A. Cultural narratives in engineering

In this section, we briefly review aspects of U.S. engineering and engineering education culture that we claim influence Ashley's decision-making.

The profession and academic discipline of engineering within the U.S. has long been dominated by white, male, heteronormative ideals [9,10]. We focus on Rigor, Meritocracy, Individualism, and the interplay among them. The concept of academic rigor within STEM fields and engineering in particular serves to naturalize separating students into two distinct groups, those who *can*, and those who *can't* succeed. Those who *can* are rewarded with membership and opportunity while those who *can't* have those privileges withheld [11]. In the most egregious cases this concept of not being able to handle the academic rigor is leveraged against marginalized students as evidence that they can't succeed. In addition, if those students don't succeed, that serves as evidence of their group's inability to handle the rigor required of engineering students and engineers [12].

This separating of students into those who *can* and those who *can't* is further reinforced by the culture of meritocracy within engineering. Meritocracy is the belief that those who succeed do so because they have earned it through hard work and intelligence and those who fail do so because they lack those qualities and therefore did not deserve to succeed. In the U.S. this cultural narrative reinforces and is reinforced by the outsized role that engineers play within society in creating—and equally importantly, shaping the narratives around—technological "advancements" and the deep integration of these technologies in industry and day-to-day life. Unsurprisingly, this results in an engineering culture that highly values the achievements of *the individual*. Those who succeed with minimal help are celebrated and students end up competing amongst each other for not only recognition and validation (grades, praise from professors, internships, etc.) but also for social positioning within their programs—despite a concurrent emphasis on collaboration enacted in design courses but not in most engineering "content" courses. By contrast, as discussed above, students who struggle or get low grades are cast as "not cut out" for engineering, as not meriting success in this exclusive field. No central authority needs to enforce these cultural narratives of individualist meritocracy based on ability to handle academic rigor. Deep immersion in the culture of their engineering programs can lead to internalization of these cultural narratives, turning would-be critics into "agents of cultural reproduction" [13]; even students disproportionately harmed by these narratives often interpret and express their struggles in a way that maintains the status quo. Although Ashley generally does well in her courses, we see this internalization-and-reproduction dynamic play out in Ashley's case study in a way that pushes her away from collaborating with her peers, even when doing so might benefit her.

II. METHODS

A. Data collection and analysis

Our case study of Ashley is part of an ongoing project at the University of Maryland that focuses on engineering students' use of online solutions. We asked students to audio-record their thoughts while doing their homework assignments or immediately afterward, focused on their decision-making around using online solution sites such as Chegg and their opinions about the course, its structure, anything they felt impacted their experience, and how they felt about collaborating with their peers or reaching out for help. We followed these auto-ethnographic reflections with one- on-one virtual interviews exploring the same issues. We used the same protocol for every student's first interview, however, subsequent interview protocols were more individualized, constructed using each student's auto-ethnographic reflections. We interviewed students three times (on average) throughout the semester. For Ashley, this data collection procedure resulted in twenty reflections and three one-hour interviews. Using this data set, we coded for themes within students' experiences, and later used the coding analysis to guide rich analytical memos that elaborated on the most salient features of students' experiences and the factors that influenced their decision- making around using external resources like Chegg and collaborating with peers. These memos informed further rounds of thematic analysis to isolate the most influential factors in student decision-making. Themes most salient in Ashley's data included self-sufficiency, strategizing, and course expectations.

B. Bounding the case study

This case study focuses on Ashley, a student taking a sophomore/junior-level Dynamics course. An Engineering/ Music double major, Ashley is a regular and unapologetic user of online solutions. This is what piqued our initial interest in her for a case study, given the focus of our broader study. Ashley also often talked with passion about her views toward collaboration. She tends to avoid it. Ashley's default strategy when she gets stuck on a problem is to use Chegg. If Chegg does not help diagnose her mistake, only then does Ashley reach out to her peers for help. In some cases–say she's satisfied with the points she's earned–she will opt to leave a problem incomplete and only to check her work against her peers in class when it's convenient. Despite having a group of supportive, same-gendered peers, Ashley views collaboration as a last resort. In this paper, we try to understand this preference for using Chegg over seeking support from her peers, as one of many case studies we are generating.

III. FINDINGS

A. Ashley avoids helping struggling students

When Ashley is first interviewed on what she thinks about the peers in her course she doesn't know what to share, stating, "I don't talk to them. I have no idea." She qualifies this statement by sharing her views on why students might not talk to each other.

"I'm sure some of them are very welcoming and they're like me and they're just a little bit nervous to talk to other people. And I'm sure some people, I mean, we're all doing well enough on our own, um, if we're not talking to each other."

Here we see Ashley base an interpretation on her own personality: some of the other students are probably just shy or introverted. However this is accompanied by the idea that successful students don't need to talk to each other, and, by extension, that the only reason to collaborate is to seek help when struggling. Following this logic Ashley then positions herself as a student who *can* by saying:

"This is also a personal problem I have, um, I tend to get a little bit frustrated when people aren't on the same level as me. [...] You can kind of tell uh like, oh, like maybe I would wanna talk to that person because we're working at the same speed."

Labeling this stance a "personal problem I have," Ashley acknowledges soon afterward that her attitude may appear unkind. Given her desire to succeed, however, any student who *can't* and may slow her down evokes frustration. By contrast, students "on the same level as me" who can "keep up" or work "at the same speed" are potential collaborators; they're not marked as potential burdens. In this way, students who *can* are rewarded with access to collaborative spaces that can further their success. In dividing other students into those who *can* and those who *can't*, Ashley both reflects and helps reproduce the meritocratic engineering culture that invites this kind of sorting of students.

In the same response, Ashley clarifies why she tends not to collaborate:

"I tend to lean away from the people who can't pick it up as fast. Like I would love to be patient with you if you're a very nice person. Like, sometimes I do like explaining cause it helps me learn better. I've learned that from tutoring. Other times I'm just like, no, I just wanna like be bouncing ideas off of each other because I'm thinking at like fifty miles an hour and I just need to keep going."

We see Ashley double down on not wanting to work with students who *can't* while also sharing that, from her tutoring experience, helping others can aid her own understanding. If a student is "nice," and if explaining the material to someone else might aid her understanding more than just continuing to bounce her own ideas "off of each other" at high speed, then she might help the other student. However this is framed as a choice Ashley has the privilege of making. Her course grade, which serves as a marker of and reward for her merit as an engineering student, depends only on her performance as measured on products produced mostly or entirely as an individual (homework, exams). In this way, the meritocracy and individualism embedded in the course structures and surrounding culture allows students who *can* the privilege of denying aid even if it could be beneficial to both students. Here, Ashley takes advantage of and recognizes that privilege. It is more important to be able to succeed on your own, and if you can't, then you are at the mercy of successful individuals to decide whether or not to help.

B. Ashley avoids asking peers "dumb questions"

In the conversation recounted above, Ashley takes on the privileged position of potentially helping another student. So how does she react when positioned as a student needing help? The following excerpts come from Ashley's reasoning about not using the course-integrated Piazza, a message-board platform that allows students to ask coursework-related questions anonymously and can be answered by either their peers or instructors. It is one of a few course structures deliberately implemented to encourage students to collaborate. When asked why she is hesitant to post questions on Piazza, Ashley states:

"Well, you, sometimes I look at it and I'm like, dude, that's a dumb question. [..], I know I shouldn't, I'm like, we're all at our own progress pace and that's completely fine, but…"

We can see that while Ashley avoids directly insulting the student who posts a "dumb question," she does pass judgment on the questions themselves. Questions that suggest a student is not keeping up with the course are "dumb questions" and mark the student as a student who *can't*. Even though Ashley acknowledges that "I know I shouldn't" have such an unkind reaction to a low-level question, this nod toward kindness is overridden as she places the blame on those students for asking "dumb questions" in the first place. Her internalization of meritocracy and individualism may contribute to her passing these judgments on her peers. Stronger evidence for this inference comes from her fear of her questions being judged the same way, a fear that keeps her from posting her own questions. She continues:

"My progress pace, if anything, is gonna be shared between me and the professor and not me and the class. Um, so if I go to office hours and I'm struggling with the problem, cool. Totally comfortable with that. If I know it's a dumb mistake or I know I'm like falling behind on something cool. That's between me and the professor. Um, not really cool with broadcasting all of that to the class, even if it's anonymous. It's just not my thing and I like to be self-sufficient anyways."

Ashley wants her course struggles to be kept between herself and the instructor. If she needs help with her own "dumb question" the only person she wants answering—or even *knowing* about the question—is the instructor. Here we see Ashley trying to avoid the very same ridicule she passes onto her peers. An anonymously-posted question can't result in Ashley suffering derision from other students, but it can result in her *question* suffering derision, and the thought of such derision goes against her desire to be "self-sufficient." In her view, a self-sufficient student can ask a "dumb question" to the instructor but not to other students. (Ashley doesn't explain why the instructor holds this special status; we assume it's at least partly because, in academic culture, students are *supposed* to learn from instructors, and students prove their merit to instructors through good performance on homework and exams, not through their "performance" in office hours.) In refusing to post a potentially "dumb question" to Piazza, Ashley cuts herself off from a source of help that's often more immediate than seeking the instructor's assistance. But "broadcasting" to her peers a question that could mark her as a student who *can't* isn't worth the potential benefit. From this and similar sentiments expressed elsewhere in the dataset, we infer that Ashley not only "like[s] to be self-sufficient" but also *identifies* as a self-sufficient engineering student, an identity forged in part—or at least reinforced—by internalization of the individualism and meritocracy baked into engineering education culture. A student who *can* is self-sufficient.

So far, we have argued that Ashley's avoidance of collaboration outside of class stems from a combination of (i) personal traits and tendencies such as shyness ("they're like me and they're just a little bit nervous to talk to other people") and (ii) internalization of aspects of engineering culture, specifically meritocracy and individualism with respect to handling the rigor of engineering coursework. Other transcript segments not presented above also suggest the influence of marginalization arising from the masculine culture [14]—and disproportionate representations of men—in engineering; when Ashley does consider collaborating on homework, it's with the few other women in her class. Below, we'll argue that (i) and (ii) interact and can't be fully teased apart. First, though, we explore a third factor contributing to her avoidance of collaboration.

C. Chegg meets most of Ashley's needs

Ashley's go-to source of homework help is Chegg. While Ashley could simply copy the answers, she instead uses the full solutions to check her own reasoning and refine her approach—mirroring the behaviors and outcomes coveted in productive student collaboration [15]. In her first interview Ashley recalls her process for assessing mistakes when inputting her homework answers into the software platform used to collect and grade homework, a platform that scaffolds students through the multiple parts of a complicated problem and gives students multiple chances to reach the right answer:

"If I get a question wrong, I'll start plugging in numbers I know have to be part of the solution until I can figure out what number I missed out or how they go together. So I did that and then figured it out- this is part of the things I didn't know I could do. Um, I figured out, how they went together, but I didn't understand why, and then I looked up the problem and then it told me why I could do that."

Her process involves using the built-in feedback of the homework software to separate which parts of the problem she has correct. Combined with trial and error, this approach sometimes allows her to get the correct answer but without understanding *why* it's correct. After isolating what she doesn't understand, Ashley compares her problem-solving approach and explanations with the Chegg solution. This helps her sense-make about what she was doing incorrectly and why the correct method works. In this way, Ashley's "interaction" with Chegg in some ways mirrors what we might expect to see in an interaction between a student who *can't* and another who *can*. However, Ashley gets to avoid the cultural markers associated with seeking out help. In brief, Chegg is often effective for helping Ashley learn the material (as opposed to just supplying answers), likely contributing to her good performance on exams; and using Chegg allows her to circumvent being labeled a student who *can't*. This makes Chegg a viable alternative to collaboration much of the time, and the existence of a viable alternative helps explain why Ashley tends to avoid collaboration.

IV. DISCUSSION

A. Summary of findings

Ashley's default tendency to avoid peer collaboration makes sense in light of three complementary factors: the convenience of sites like Chegg, at least for middle class students who can afford it; Ashley's self-professed shyness; and the threats inherent in collaboration within the culture of undergraduate engineering, especially (but not only) for women and other groups traditionally excluded from engineering. Ashley has been immersed within the culture for at least two years and shows evidence of having internalized beliefs and ideologies of meritocracy and individualism: a good engineering student succeeds in coursework based on their individual talent and hard work (self-sufficiency!), thereby earning their status as a student who *can*, and later, as an engineer. Her fear of being marked as a student who *can't*, complementing her identification as a self-sufficient student, influences her avoidance of collaborating with her peers.

Prior research establishes that students from groups underrepresented in engineering are particularly likely to be labeled as students who *can't* [16]. Although Ashley did not discuss sexism explicitly, we see hints that it plays a role in the constellation of factors contributing to her reluctance to collaborate. Specifically, she says she'd reach out to the few other women when collaboration becomes necessary.

But typically, she doesn't need to collaborate because of the plethora of online resources available outside the classroom. Chegg happens to be Ashley's resource of choice, and she puts it to use in ways similar to how she would a knowledgeable peer–a peer that won't judge her mistakes or "stupid questions," available essentially at all times, and removed from cultural narratives of Meritocracy and Individualism, which grants her the relief of interrogating her misunderstandings at no risk to herself. Critically, we're not advocating for Chegg or any other resources as replacements for peer collaboration. Student collaboration can benefit all involved [17]. Our point is simply that instructors and researchers need to understand Chegg's role in supporting Ashley's avoidance of collaborating so that we can better create learning environments that help Ashley turn towards collaboration.

B. Entanglement of factors

It's tempting to view personality traits like shyness as a separate kind of influence on behavior from cultural narratives such as meritocracy and individualism. Ashley's case suggests that these two kinds of influences are difficult or even impossible to tease apart, not just empirically but also conceptually. Her identification as self-sufficient, we argued above, stems at least in part from her internalization of meritocratic and individualistic beliefs and ideologies. But her self-sufficiency and pride therein isn't *just* a manifestation of cultural narratives. Ashley helps lead a campus orchestra while juggling her Engineering/Music double major, while also taking on responsibilities in other campus groups. Our interviews didn't probe this point, but we find it likely she came to the university with a sense of competence and self-sufficiency, at least in some spheres. And we suspect these pre-existing elements of her personality or sense of self interacted with the cultural narratives she was internalizing as she came to identify as a self-sufficient engineering student. We lack the data to explore this point further. For now, we're just offering a plausibility argument that personality traits and internalized cultural narratives interact strongly or even partially merge in the context of engineering students' decision-making around collaboration and perhaps other aspects of their approach to coursework.

An implication of this idea is that researchers exploring engineering students' decision-making about collaboration, use of online resources, and other aspects of their study habits will get a fuller picture by not only exploring the influence of personality traits (and personal beliefs and other student characteristics) *and* cultural narratives (often embedded into course structures) but also looking for interactions or entanglement between these two kinds of influences.

These cultural norms are so deeply rooted they become difficult to challenge. The expectation that students challenge these cultural narratives alone is absurd, but even instructors fighting to shape their courses around collaborative learning are at a decades-spanning disadvantage. We should expect that as long as solution sites like Chegg exist, and as long as engineering culture stays as it is, students will frequently use online solutions in place of collaboration. Future goals of this work include crafting potential interventions for instructors, as well as further exploring how cultural narratives manifest within a broader student body and impact their decision-making.

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