Students' Engagements with Reflection: Insights from Undergraduates

Wendy Roldan, University of Washington

Wendy is a second-year PhD student in Human Centered Design and Engineering at the University of Washington studying the development of equitable engineering education. Her work draws from the fields of engineering education, design, and learning sciences.

Dr. Jennifer A. Turns, University of Washington

Jennifer Turns is a Professor in the Department of Human Centered Design & Engineering at the University of Washington. She is interested in all aspects of engineering education, including how to support engineering students in reflecting on experience, how to help engineering educators make effective teaching decisions, and the application of ideas from complexity science to the challenges of engineering education.

Ahmer Arif, University of Washington
Ms. Gina Tesoriero, University of Washington

Gina Tesoriero was a special education teacher in New York City public school for a decade before moving to the Pacific Northwest to begin a Ph.D. program in the Learning Sciences. She has worked with NYC museums to develop professional learning for teachers, created a STEM program at two schools, and consulted on NYC's STEM Handbook and Framework. Her research interests center around teacher professional learning, special education and engineering education.

Ms. Yuxin Xu, University of Washington

Yuxin (Ziva) Xu is a second-year undergraduate student at University of Washington, Seattle. Her research areas of interest include reflection in engineering education, equity in engineering, and human-computer interaction. Address: 746 1035 NE Campus Pkwy, Seattle, WA 98105 Phone: 206-209-6202 Email: yxxuziva@uw.edu

Students' engagements with reflection: Insights from undergraduates

Introduction

In this research paper, we situate our work in an understanding of reflection as a form of thinking that involves stepping out, thinking about, and connecting forward [1]. There has been growing interest in supporting and promoting student reflection in engineering education, a situation that likely has a number of reasons [2]. For one, reflection, as we have described it, is a knowledge producing mechanism, and educators may be interested in any of the ways that students construct knowledge. Second, as higher education has become more interested in experiential forms of pedagogy [3], reflection (as the time spent making sense of experiential learning experiences) is certainly important to think through. In addition, reflection is a mechanism for learning that is available throughout life, and thus reflection is connected to notions of lifelong learning [4]. While some may ask "does reflection work," we believe a more critical question is exploring how educators can go about supporting, encouraging, and facilitating student reflection in meaningful and useful ways as part of students' educational experiences in higher education.

To help students, though, we need to understand students. We need to appreciate students' own understandings of, engagements with, and attitudes toward reflection. Such information can help with effectively attending to student reflection by knowing how to craft reflection opportunities and reflection activities [5]. Such information can help us understand how to scaffold the difficult aspects of reflection, and how to frame reflection opportunities in ways that help students engage. In addition, we need to be able to respect and honor the role that reflection plays in students' lives outside of higher education. We also need to understand the extent to which negative associations with reflection may result from unintended consequences of reflection activities in higher education. Knowing more about students' perspectives on reflection can help us be effective educators and also more responsible, ethical educators.

In this work we sought to understand undergraduate students' perspectives on reflection, specifically the types of engagements they have had with reflection. In our analysis we identify meanings in motion, varied practices, felt engagements and a school-life divide as important for understanding students' perspectives.

Related work

Reflection can be understood as a form of thinking that involves stepping out, thinking about, and connecting forward--specifically, stepping out of prior experiences/current thoughts; thinking about those prior experiences/current thoughts to make sense of them, question them, integrate them with others; and then stepping back in and connecting forward to action. This way of understanding reflection is consistent with Dewey's notion of reflection as a form of problem-solving the events that happen in our lives [4] and also Schon's notion of reflection in action as something key to professional practice [6]. Reflection as a form of thinking is interesting from a theoretical perspective because of its connection to metacognition, its role in learning from experience, and its opportunity to provide a site for students to critically question the world around them.

Recent research suggests reflection is interesting in practice as well as theoretically. Carberry and his colleagues reported on a study to address how engineering educators, students, and practitioners define reflection and use it in their personal, professional and/or academic life [7]. Their results showcase how students, faculty, and practitioners perceive their use of reflection.

Across personal and professional life, the top reported uses of reflection were for remembering, improvement, meaning making, and making decisions. Interestingly, although some participants were coded as reporting "no use," this was extremely rare in the sample. Inverting the reported numbers of "no use," we can note that 99% of students reported professional and personal use and 100% of practitioners reported professional and personal use. Further, for faculty, 100% reported personal use and 97% reported professional use. These data suggest that reflection is associated with a range of uses, and also that reflection is being used by students, faculty, and practitioners. While Carberry et al.'s data do not address the frequency of use, the effectiveness of use or the satisfaction associated with use, the data do speak to a prevalence of use [7]. Carberry et al. point to a limitation of their data collection methodology noting that "the mode of survey delivery may have led to shorter and less thoughtful responses" [7]. In our work, we complement Carberry et al.'s study by offering more in-depth narratives of students' perspectives on reflection through semi-structured interviews.

In our work, we captured narratives about students' engagements with reflection, such as the narratives shared by Boswell [8]. Boswell reports on a specific effort to support student reflection during an experiential learning opportunity (an alternative spring break). Initially, Boswell's team had planned highly structured, daily reflection activities. Over time, they learned students had negative reactions to the trips' structured reflections. Using the notion of the "structure trap" to capture the unintended consequences of over-structuring student reflection, Boswell goes on to explain how her team let go of a commitment to structuring student reflection in order to support naturally occurring reflection. This work suggests that tensions can be associated with supporting student reflection in school versus in life. Further, Boswell's account suggests the value of thinking critically about student engagements with, and possibly resistance to reflection. We extend this work by offering additional stories of engagements.

Student resistance, as a form of student reaction, and educator response is a subject of interest in engineering education scholarship. For example, Tharayil et al. recently published work on how educators address student resistance to high impact pedagogical strategies [9]. Tharayil et al. highlight "...understanding student resistance as a barrier has not yet been adequately researched" [9]. Using interviews with educators, their work examines the relationship between instructors' use of strategies and students' responses. Tharayil et al. find educators use explanation and facilitation strategies like explaining activity expectations and using incremental steps to reduce student resistance [9].

Tharayil et al.'s specific strategies as well as the general narrative from Boswell speak to how resistance to reflection can be addressed [8], [9]. The general frame of resistance, however, is troublesome. Work that focuses on student resistance can fail to problematize the interpretation of student behavior as resistance as well as the source of any potential resistance. Thus, in this work we have an eye toward resistance but focus more generally on students' accounts of their engagements with reflection and associated reactions.

Our work focuses on the experiences of undergraduate students through interviews. This approach enables not only an understanding of in-depth students' perspectives on reflection but also provides us a space for critical analysis of engagement through their first-hand experiences.

Approach

Multiple theories informed our methodological approaches to this work. We draw on qualitative research in engineering education, postmodern feminism, and ethnomethodological perspectives.

Further, we sought to complement the efforts of other researchers in engineering education who ask how students define reflection [7], who suggest letting go of the "structure trap" to support student reflection [8], and who offer strategies to reduce student resistance [9] by listening to undergraduate students' engagements with reflection.

We approached our work with an emphasis on conversational interviews with participants, identification of dimensions along which our participants varied, and construction of narratives showcasing the participants in relation to the dimensions of variation. We treat the reflection activities in which students engage and their practical sociological reasoning for engaging in those reflection activities as informing our understanding of what counts for them as reflection.

Interview protocol. To do this work, we started by constructing an interview protocol to capture a variety of issues around reflection and used the protocol as the foundation for single, hour-long, open-ended conversations with participants. The interview protocol consisted of questions that invited participants to (a) talk about their understandings of reflection, (b) create a "reflective inventory" where we asked each student to share stories of engagements they had with reflection (both in school and out of school), (c) share their thoughts related to technology, and (d) share their impressions about possible reactions undergraduate might have to reflection activities.

We interviewed six full-time undergraduate students, five from a research university (which we recruited via a listserv that reaches technically oriented students) and a sixth from an engineering department at a smaller nearby university. When selecting participants from those who had expressed interest, we sampled for variation. We do not believe that we reached saturation with these six interviews, but we do believe the interviews led to findings that are worthy of conversation. The participants vary by gender, by academic level, and by discipline (although all students have a connection to engineering in their academic endeavors). In addition, as our analysis confirmed, the participants varied by their experiences with and attitudes toward reflection. The interviewing took place over a three-month period. Five of the interviews were conducted by a pair of interviewers; one of the interviews was conducted by a single interviewer. The interview protocol was a starting point for an open-ended conversation between researchers and students. Each interview was followed by a debriefing session among researchers to explore emerging themes. These debriefing thoughts were carried into the subsequent interviews, as is consistent with this form of interviewing.

To systematically analyze our data, we transcribed the interviews and used constant comparison techniques to identify themes of relevance to the goal of designing to support reflection. Drawing on the work of Million et al. we take a felt engagement approach to analysis that allows us to create a context for complex telling honoring the stories of the undergraduate students. Felt engagements draws on the notion of felt theory from the work of Million, who described a felt analysis "as one that creates a context for a more complex telling" [12]. We draw inspiration from an indigenous feminist approach where they see the personal narrative as a powerful tool to empower individual experience [12]. Using the results of our thematic analysis as a guide, we crafted narratives for each participant. The narratives for five of six participants are presented in the first part of the results. The narrative for the sixth participant is presented in a second part of the results along with additional information on this participant's reported engagements with reflection because of what proved to be interesting features of those contrastive engagements.

Trustworthiness. Our responsibility in this work is to ensure that the reality presented below is consistent with the world as experienced by the participants [10]. In order to accomplish this

responsibility, we needed to carefully attend to how we made data and handled data [11]. In the making data phase, we leveraged semi-structured interviews so our participants could feel comfortable to share their experiences. In order to reduce the power distance between the interviewers and student interviewees, graduate students conducted the interviews and established a rapport with each of the participants during the interviews. In the handling data phase, our practices included engaging in peer scrutiny to strengthen our ideas. Peer scrutiny allowed us to consider and eliminate alternative explanations to our data analysis. In addition, we focus on providing thick descriptions in the text that follows. The combination of thick descriptions and a focus on felt engagement strengthen the credibility of our analysis by offering significant detail of students' engagements with reflection and the context surrounding these engagements from their livex experiences [10, 12].

Results I: Student Insights on Reflection

As we looked across the information we gathered from our participants, we noted four themes: definitions in motion, varied practices, felt engagements, and school-life divide. Below we offer narratives for five of our participants (using pseudonyms). These narratives were crafted to illuminate our four themes and are ordered by the academic level of the student whose narrative is being told. At the end of this section, we discuss our four themes in light of the individual narratives before focusing in more detail on an additional participant and three contrasting engagements with reflection that she recounted.

Mateo: Choosing to engage in personal reflective activities.

Mateo was a 2nd year undergraduate student studying design. When asked about whether he finds reflection to be useful, Mateo said, "Mainly, my reflection will involve other people a lot, my interactions with other people, and also involve reflecting on my thought process through something." Mateo said he preferred to reflect with others, "... you need to have checks and balances of other people to reflect with because if you just reflect all on your own, then you could definitely just be lying to yourself."

Mateo engaged in a range of reflection activities that helped him think about conversations with his girlfriend, time management practices, and what it means to love yourself. When he told us about the reflective activity he engaged in after having an uncomfortable conversation with his girlfriend, he came up with questions such as: "Was it just the timing? Why was it that way?" He also shared with us a reflection activity that his dad designed for him when he was younger. He had to brainstorm and organize his time management practices through writing and excel sheets where he would document how many hours he had worked per week and reflect on what his priorities were. While talking about this activity, he realized, "my dad and I process through things very differently." Mateo also shared that when he journals, he writes in the form of letters that he never delivers, including letters to himself, to God, or to someone else. Afterwards he found himself asking, "But then, it's like, if you sign off with 'I love you,' it's like, do you actually really love yourself?"

Like other undergraduate students interviewed, Mateo seemed to create a disconnect between personal reflection and academic reflection activities. When asked about what more he would want in the classroom in terms of reflection, he expressed a desire to "sit down at the end of the quarter with one of my professors… lay out my work and just have their attention for 30 minutes." For Mateo reflection was, ".. reflecting [on the] past so that I can learn in the present so that I can do better in the future kind of thing."

Wynnie: Seeing reflection like spring cleaning for the brain.

Wynnie was a third-year undergraduate student. At the beginning of our interview, Wynnie expressed her confusion with personal reflection and academic reflection. When asked about her understanding of reflection, Wynnie shared that during experiences with academic reflection, "sometimes I look at the paper the assignment or whatever prompt they've given me, and it almost feels overwhelming."

Wynnie shared that when she was younger her parents would ask her to write in a journal in Korean because they wanted to make sure she maintained knowledge of her native language. When reflecting on this engagement with reflection, she shared, "I hated it so much, it was unpleasant." Yet, as a college student, Wynnie noted her appreciation for free writing, an activity where she would take paper, pencil and write down all her thoughts in free form which felt "like spring cleaning for your brain."

Mia: Appreciating reflection activities in the classroom.

Mia was a final-year psychology major who took engineering courses during her first year and is still involved in the engineering community. Reflection was a broad term for Mia, but she identified it as, "instances where I've sat down after a long day and thought about what's happened, so that's what I think about when I think reflection, just thinking about the past." When prompted whether she agreed with a particular reaction to reflection, Mia shared that some of her friends might find it less than useful because "reflection is not an efficient thing." Mia went on to explain that "efficiency is engineering, but it's also American."

In contrast, reflection in some classrooms did have value to Mia. She said, "I've had a couple classes here with one professor who has us meditate at the beginning of class, which is a little bit different from reflection that I would say I do in my normal life, but I find he does it at the beginning of class, and it's less to reflect on any material or anything, but it's really just to sit down for a minute or two." Mia saw the activity as a time to "just to acknowledge the thoughts and feelings that you've come into class with and then to put them in the correct place and to then be present in class." Reacting to this reflection classroom activity, Mia said "I really like [it]. I know there are some people who think it's weird, but it's one of those things that it's like if you don't like, but it doesn't do any harm to them and it is helpful to some students."

Mia shared that she engages in wide swath of reflective activities in her personal life that include spiritual practices, listening to music, and exercising. She described listening to music and relating to the lyrics to name her emotions. Mia said, "It's usually slower, acoustic stuff, always with lyrics though and listen to words if I want […] Usually I'll grab onto a phrase that they said and then focus on that and what I'm relating that to in me for a while and not listen to the music so much and draw." When asked what she gets out of this reflection activity, Mia responded with "I think just…same thing with journaling, just naming the whatever emotion is." Mia said exercising "provides space for a lot of people to reflect" and rationalized taking time to run and reflect because "that's healthy for me as opposed to just setting aside time to sit in quiet." Mia said, "It's harder to come up with a reason to justify why you can set aside that half hour to do that" referring to "just setting time aside" to sit in quiet.

Carmen: Seeing academic and personal reflection as distinct.

Carmen was a final-year undergraduate student in an informatics program. Carmen described reflection as "introspection" that allows her to "connect the dots" of different things that she has

done in her life. She shared that reflection helped her apply to graduate programs. She said, "everything starts to make sense [of] why I made a decision one after the other." Carmen shared that applying for graduate school can spark a "positive reflection," but she also explained that other activities can trigger "negative reflection."

Carmen expressed a dichotomy she felt between personal and academic reflection. While Carmen considered personal reflection to be a supportive activity, she considered academic reflection to be frustrating. Carmen considered writing in her diary, talking to people, and thinking on her own as opportunities to engage in positive reflections. While she saw personal reflection as an active process, she described academic reflections as a more passive process. Carmen explained that academic reflection were prompted by assignments. She explained that these types of reflections were not helpful since, "you just keep thinking what you can do better, but I just don't feel like those are something I should do often, because it's really not positive things and productive." During our interview, Carmen also questioned the purpose of reflection in the classroom saying, "it is for the teacher's benefit, not my benefit."

Carmen told us about a time when she had to write reflection essays for homework and the only parameter she was given was word count. Carmen said the reflection activity was framed as a homework assignment and it felt forced. Carmen shared that reflections that are due on Friday especially feel like another assignment because, "I'm going to get an A on this. It doesn't matter." She said, "I don't want to feel we are forced but if they are like, you have to write a reflection essay for 200 words, or 50 words... You are not really reflect[ing], you are like 'I just want to write something to complete this thing.'" She discussed the implications of framing the activity as homework by saying, "It happens, because you just want to finish and just do the homework, if it's put out as homework."

Caleb: Questioning reflection in the engineering classroom.

Caleb was a final-year engineering student at a small, Jesuit university. At the beginning of our interview Caleb, similar to Carmen, shared that he had somewhat of an understanding of the word "reflection" but was still not confident in his understanding of the word. He noted, "I mean, maybe not from a level of verbal articulated definition, but in terms of just feeling that I know what it is, but not to its fullest extent." Throughout his interview, Caleb shared with us personal engagements he had with reflection related to instances reminiscing and recollection. In one of his advanced math courses, when reminded about a concept from an earlier course, he and his peers reminisced about those classes together. When interviewed, Caleb was toward the end of his undergraduate experience and also shared with us that visiting physical spaces on campus evoked emotional responses to recollecting these memories about his time in school.

When asked about reflective activities he had done in the past, Caleb said running and playing music. He saw running as helpful because it always "brings back nostalgia" and helped him feel better by helping him get to a "clear head space". Playing instruments without sheet music was another form of reflection he identified because, "in terms of recollection and in terms of just finding a place where that's what I'm focused on, that's where it's at."

Caleb said he found reflection to be something that was useful in the context of his engineering work because "everything's very tied together and it's better to have a wide base of knowledge." Within engineering contexts, Caleb recognized reflection as necessary to making sure project steps were documented and that students were reflecting on how they have grown through a project because it is one of the things he has been asked to do in his classes. When asked about

his fellow students' reactions to professors prompting students to reflect, he said, "when it comes to non-engineering things, I've certainly witnessed if not experienced it myself, why are we doing this." Caleb suggested students tend to focus on the end product rather than the means and processes of a project. He hypothesized this focus on the end product, could be related to some of the negative feelings his peers might have towards reflection in the classroom.

Synthesis

Meaning in motion. Reflection is messy and the undergraduate students we interviewed are still making sense of reflection. With Carmen, we learn about the muddiness of the concept of reflection for undergraduate students. Carmen was trying to make sense of what reflection was throughout our interview and during the interview would sometimes question her previous assertions of what reflection meant. Our interviews with undergraduates raise questions about how students see reflection, what counts as reflection for them, and how their negative emotions toward reflection be caused by inferences made from individual instances. We see this messiness around the concept of reflection exacerbated in Caleb's interview where he muddles over the role of reflection in the engineering classroom and begins to distinguish between reminiscing and reflection.

Our conversation with Carmen also offered a nuanced understanding of the confusion that students experience when conceptualizing reflection. For example, when Carmen talked about her experiences writing her graduate school applications and said, "everything starts to make sense" we can start to question whether things are making sense or if she is constructing sense. When Carmen said some activities create a negative reflection, it is not clear if she is referring to a negative experience with reflection that triggered negative emotions or a negative engagement with reflection that was poorly set up.

Varied practices. From Mateo's interview we observed the many types of reflective activities undergraduate students may engage in. Contrary to the notion that undergraduates dislike reflection, we learn that they are actually engaging in many reflective activities in their personal life. Caleb shows us the many ways in which undergraduate students design their own reflective activities. The detail to which running and reading sheet music are a part of his daily reflections is similar to what we see with Mia's interview. Across the interviews, the students identified many ways in which they engage in reflection and conveyed a desire to do more reflecting. We heard about journaling, blogging, meditation in class, capstone team conversations, reminiscing through smell, reminiscing using social media reminders, playing music, listening to music, drawing, sketching, documenting, calendaring, planner, running, exercise, texting friends, and talking to others. From these insights we might ask, how could educators draw on this naturally occurring variation in the design of reflection activities for engineering education?

Felt engagements. We are drawn to characterize the students' accounts of reflecting as felt engagements in order to capture the types of associated affect (i.e., positive, negative, awkward, unpleasant). In their work, Million argues that in order to capture "their story" (of Native scholars and community members) individuals' feelings "must re-enter their accounts, which would be incomplete without them" [12]. In this work, felt engagements are meant as a way to capture the feelings in students' accounts of reflection.

For Wynnie, although some reflective activities caused negative emotional responses, she still felt reflection was beneficial, so she engaged in reflections on her own time. Carmen's interview highlights how reflections can be helpful when they feel personal. It can be helpful if reflection

activities are able to provide opportunities to connect actions to future goals and help students see things in different perspectives. On the other hand, reflections that are not personalized, might not inspire the deep introspection needed to prompt beneficial reflection.

In Mia's interview we see a more detailed description of the value of reflection in the academic context. But we also see Mia wrestling and feeling conflicted with the known value of reflection while rationalizing the time to needed to reflect. Despite a positive experience with reflection in the classroom, Mia also shared with us that reflection "doesn't feel productive in the same way that schoolwork does." This theme is highlighted throughout all of our interviews as students navigated tensions between taking time to engage in reflection or work on a pressing assignment.

By engaging in reflection activities, students appreciated the space to sit in silence. From engaging in reflection activities, students say they started to make things clearer in their mind. They shared the before and after differences of taking time to reflect. Before reflecting, everything seemed messy and afterwards, things became clearer for them. Student said things along the lines of, "Now I can make sense of how things connect to other things" and "Now I can process why I did something and how that set me up for the future" when asked about what they get out of reflection. By engaging in reflection activities students felt they could name their emotions. There is something nuanced for them about calling attention to it, documenting it, naming it. Prior to a reflection activity, students said they felt their emotions were not captured or named. After engaging in reflection, their emotions became articulated which helped them decide whether or not to act on those emotions or not.

School-Life Divide. Mateo was eager to share with us his personal reflective practices yet became hesitant when asked if he reflected in the classroom and how he experienced those activities. It is surprising to learn that like Mateo, other undergraduates in our study also created this dichotomy between academic reflection and personal reflection. Some of the key insights from Mateo are echoed in Carmen's accounts of reflection. But Carmen also offered a nuanced understanding of how undergraduates may see personal reflection as distinct from academic reflection. Carmen, like Mateo, highlighted the distinction undergraduate students create between personal and academic reflection. Like other participants, Wynnie noted a difference between reflection by choice and reflections that she was told to do by her professors or family members.

Results II: Deeper Dive on Student Engagements with Reflection

In this section, we take a deep dive into one student's contrasting engagements with reflection. Elizabeth is a final-year undergraduate pursuing two degrees (human centered design and computer science). After being asked about her understanding of the word reflection, Elizabeth shared that she had a good grasp on what it meant. Elizabeth said, "...when I think of reflection, I think I generally know what it's referring to. It's kind of looking back and processing what's happened. Making connections, and things like that."

<u>Engagement 1: Reading books over a two-week period.</u>

During her undergraduate experiences, Elizabeth felt that she did not she did not have time for herself given her rigorous course load, extracurricular activities, and internships. When she found herself having a three-week period off during her final year of college, she decided to spend a two-week break reading and writing as a way to reflect on the many moving pieces of her life. Elizabeth said, "It seemed like everything was moving so fast and I didn't really have control of what I could do or my situation or even process what was happening, whether it was

good or bad. So, I decided, while I had this two to three week period, I should do something meaningful." Elizabeth "made a commitment" to read as much as she could in this time period. Once she had curated the set of books, she read all of them, and took notes on quotes that resonated with her. Elizabeth then shared her reflective activity and insights in a public blog post that was shared widely within her department and her peer group.

After naming this engagement, later in the interview we learned about Elizabeth's context at time of the design of this reflection activity and the consequences of this experience. At the time of deciding to do these activities, she had questions about the value of her education, emotions about the role of problem sets and assignments in life, and desires to make sense of the many moving pieces of her life. Elizabeth decided to "selectively choose books that [were] on bestselling lists on Amazon or just online in general." Although she did not describe her curation process in detail, Elizabeth shared, "it just kind of happened to fit that all the books related to my identity and my thoughts in some way." Thinking back to how that experience felt, Elizabeth said "it was a time to check in with my thoughts and myself." Elizabeth shared with us that after this experience she has become more reflective and has tried to get her friends to reflect with her.

Elizabeth's engagement with reflection by reading and responding to books over her break can be seen as impressive and offers a view into a deeply involved, personal, and fulfilling student experience with reflection. We envision Elizabeth's story serving as an inspiration for how we might design reflection activities in the classroom that feature some of the components of Elizabeth's self-designed activity. We might ask how a reflection activity in the classroom can invoke the metacognitive processes that Elizabeth made sense of when reading, writing, and crafting her blog. Next, we offer a second engagement with reflection that Elizabeth shared in her interview where she attempted to ask her friends reflective questions.

<u>Engagement 2: Sharing reflection with peers.</u>

When we prompted Elizabeth to think about who asks her to engage in reflection, she responded with, "I don't think anyone directly asks. I usually bring it up in all of my conversations." She went on to share a second engagement she had had with reflection where she attempted to prompt reflection with her peer group. She said, "I try to ask more meaningful questions to my friends when I get the time, cause I feel like time is really limited. So I spark those questions… [like] if you can have coffee with anyone on campus, who would it be? Or like, who do you look up to? It kind of makes you think."

Elizabeth shared with us that some of the reactions her peers have to her trying to spark reflective conversations. She said some see reflection as "something adults do." Others responded, "this got really deep" or "whoa, this is pretty serious. I never think about this" or "thanks for asking me, like wow. This is not something that is mostly talked about." When she shared her reflection blog post from the first engagement (that we describe above) one friend reacted with, "oh, you went ahead and did this when a lot of people in our age don't even take the step yet." Elizabeth said her friends are amazed by her reflective practices calling her "mature" and "wise beyond her years." When Elizabeth shared her reflection experiences with adults, she said they usually respond with, "your parents must be so proud." Following up on this comment, Elizabeth said "apparently [reflection] is a more mature thing, like self-awareness and life meaning type of things."

After naming this second engagement with reflection, Elizabeth shared that she could understand some of her peers' reactions to reflection being too deep and serious. She said, "you come across really tough questions when you ask what's the meaning of life… And that scares people to think

that their life just became meaningless or something like that… Because it's so much easier to turn a blind eye and be like, 'I'm just gonna keep going...from what I've seen, talking to people about reflection like my peers.' It's like, 'oh wow, you're already thinking about this. Or like, wow this is really stressful let's move on.'" Elizabeth noted that trying to be reflective with her peers, "hasn't worked with a lot of people I would say. Like, it's hard to do even with my sister who's around my age. I've only been able to do it with a few select friends, and even so, sometimes the conversation stops."

Elizabeth's third engagement with reflection was in class where she had to write a reflective essay. The way she shared this experience and discussed the consequences differs significantly from her engagement with the blog post.

Engagement 3: Writing a reflective essay for a class on disabilities studies.

In response to what reflection feels like in the classroom Elizabeth said, "...it's an assignment. And I turn in all my assignments, so it's like I have to do it… And there's some reflections that I like better than others." Elizabeth then shared she remembered, "one reflection piece that I particularly struggled with was [in a] disability studies course."

Elizabeth shared that the assignment was framed as a reflective essay in an disabilities studies class where she was given very few parameters to scaffold the activity, not given the rubric beforehand, and then it was graded "pretty strict[ly]." Thinking back to how the experience of writing that reflective essay felt, Elizabeth shared "I was scared of saying something wrong or making a generalization about disabilities that wasn't true." Elizabeth contrasted this classroom experience with personal reflection where, "you can't really say anything wrong because it's about yourself so it's subjective."

From a broad glance, Elizabeth could be considered an edge case. She is reflective in her personal life, designs activities to help her be more intention in her actions and takes on the responsibility to share the value reflection with her friends. But if we dig deeper, we see Elizabeth is very similar to the rest of our interviews. Like the other students in our interviews, she has had at least one negative experience with an academic reflection activity, an experience that seems to have contributed to her perception of reflection in the classroom.

Discussion and Implications

In this work, we focused on undergraduate students' perspectives on reflection, specifically the types of engagements they have had with reflection. Each of the six undergraduate students knew enough to have a conversation with us about reflection, were comfortable sharing their hopes and concerns in relation to reflection, were able to share their engagements with reflection, and expressed value in reflecting. Although a limitation of this work is our small sample size, by focusing on a small number of interviewees, we were able to listen to the tensions in students' perspectives and identify points of interest for future research.

Meanings in motion. To undergraduate students, reflection is not a foreign word with zero associations. With these interviews we see a range of associations that are unique across students but also not incommensurate. Undergraduates expressed their current understanding of reflection, not as rigid, but in motion. The fact that their meaning of "reflection" is in motion offers hope toward the alignment of reflection conceptualization between engineering education movements toward supporting reflection in the classroom.

We also conclude that undergraduate students know enough to confuse themselves when talking about reflection. This conclusion has an implication for teaching practices when designing reflection activities. It highlights the need to look at the precariousness of the word reflection and the meaning undergraduate students associate with it when we attempt to engage them in reflection activities. If we want reflection to be grounded, we might mediate the conceptualization of it, toward the aim of drawing on how students currently conceptualize reflection in their everyday lives to inform the design of future of reflection activities.

Varied practices. It was a pleasant surprise to see the range of practices students named as engagements with reflection. In education, we have a tendency to associate reflection with reflective writing, but reflection can take on many forms beyond writing essays. In this work we learn about the creativity and personalization that goes into how undergraduate students reflect in their daily life. Students use social media as a probe towards reflecting on their relationships, art as a medium through which they can make sense of emotions they are unable to name, and rely on important individuals in their life to engage in meaning making conversations. These interesting, varied practices are not all about writing. We suggest as educators we might want to think more about that particular connection between reflection and writing and tease apart this association to better support student reflection in engineering education.

Felt engagements. Across and within individual student experiences we see varied felt engagements with reflection. Our work is influenced by notions of felt engagements proposed by indigenous feminists [12] to offer a context of student engagement with reflection that goes beyond telling. We acknowledge the variation across students' experiences with reflection in the classroom and within students' experiences with reflection as we see with Elizabeth's three engagements. We aim to activate the positive associations with reflection, such as the one Elizabeth had during her winter break reading and writing activity. Simultaneously, we aim to be aware of the negative associations with reflection, such as the ones Elizabeth had with the reflective essay she wrote in her disability studies class.

School life divide. Bringing to the surface that students create a distinct dichotomy between personal reflection and academic reflection is important but not necessarily new knowledge. Unpacking the implications of this binary allows us to make sense of how they differentiate takeaways in these two separate instances, why students have created this divide in their head of where and how reflection can occur, and what this means for when we, as engineering educators try to incorporate reflection activities in the classroom.

The results of our work extends our understanding and appreciation of undergraduate students' understandings of, engagements with, and attitudes toward reflection. We complement the findings of Carberry et al. [7] by offering narratives of six undergraduate students which provide rich detail of how students see the meaning of reflection in motion, engaged in varied practices to reflect, and have nuances emotional engagements with reflection. In extending the work of Boswell and Tharayil [8,9], our findings conceptualize the varied types of engagements undergraduate students can have with reflection beyond instances of resistance. From this work, we are better positioned to closely understand students' perspectives and engagements with reflection as we engage in efforts to better support student reflection in engineering education.

Conclusions

We provide evidence of students having workable (even if in flux) meanings for reflection, varied practices for engaging in reflection, and both positive and negative engagements with

reflection. Our work suggests it might be interesting to further explore the school-life divide students identify related to reflection. As engineering educators design activities to support reflection, it is also important to recognize students may be more prepared to talk about reflection than previously assumed and also that they have histories that may affect how they engage in new activities. This research attempts to humanize students' experiences with reflection and offers a cautionary note about making assumptions around students and reflection. Moving forward, we suggest capturing and responding to student reactions to reflection activities, framing and scaffolding reflection activities, and designing reflection activities that allow for students to build on what they bring.

References

[1] S. A. Ambrose, "Undergraduate engineering curriculum: The ultimate design challenge," *The Bridge*, vol. 43, no. 2, pp. 16–23, 2013.

[2] J. Turns, B. Sattler, K. Yasuhara, J. Borgford-Parnell, and C. J. Atman, "Integrating reflection into engineering education," in *ASEE Annual Conference and Exposition, Conference Proceedings*, 2014, vol. 35, p. 64.

[3] R. G. Bringle and J. A. Hatcher, "Reflection in service learning: Making meaning or experience," *Educ. Horiz.*, p. 179, 1999.

[4] C. Rodgers, "Defining Reflection: Another Look at John Dewey and Reflective Thinking," *Teach. Coll. Rec.*, vol. 104, no. 4, pp. 842–866, Jun. 2002.

[5] X. Lin, "Designing metacognitive activities," *Educ. Technol. Res. Dev.*, vol. 49, no. 2, pp. 23–40, Jun. 2001.

[6] D. Schon, "The reflective practitioner," *Routledge,* 1983.

[7] A. R. Carberry, T. S. Harding, P. J. Cunningham, K. R. Csavina, M. C. Ausman, and D. Lau, "Professional and Personal Use of Reflection by Engineering Faculty, Students, and Practitioners," in *ASEE Annual Conference and Exposition, Conference Proceedings*, 2018.

[8] L. Boswell, "The structure trap: students' perceptions of reflection on a co-curricular immersion service-learning trip," *PhD diss.,* Humboldt State University, 2010.

[9] S. Tharayil *et al.*, "Strategies to mitigate student resistance to active learning," *Int. J. STEM Educ.*, vol. 5, no. 1, pp. 7, Dec. 2018.

[10] A. K. Shenton, "Strategies for ensuring trustworthiness in qualitative research projects," *Educ. Inf.*, vol. 22, no. 2, pp. 63–75, Jul. 2004.

[11] J. Walther, N. W. Sochacka, and N. N. Kellam, "Quality in Interpretive Engineering Education Research: Reflections on an Example Study: Quality in Interpretive Engineering Education Research," *J. Eng. Educ.*, vol. 102, no. 4, pp. 626–659, Oct. 2013.

[12] D. Million, "Felt Theory: An Indigenous Feminist Approach to Affect and History," *Wicazo Sa Rev.*, vol. 24, no. 2, pp. 53–76, 2009.