“It is helpful but having it due a week out might be too long”: How engineering students experience reflection activities

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Introduction

Reflection can be understood as a form of thinking that involves stepping out of a situation to create knowledge. Reflection is a significant topic for engineering education because of the significance of reflection to professional practice (e.g, Schon, 1983), the connection of reflection to metacognition, and the role of reflection in learning from experience (e.g., Kolb, 2014; Dewey, 2007). In order to support student engagement with reflection, educators create activities that help students reflect.

In this paper, we focus on the reactions that students have when engaging in reflection activities. The quote in the title of our paper offers an example of reactions that students may have. In the quote, the student is suggesting a positive reaction (i.e., “It is helpful”) but also a concern (i.e., “having it due a week out might be too long”). Exploring students’ reactions to reflection activities is a place where we see a gap in our understanding of reflection in engineering education. Core to this paper is showing how reactions can be characterized on both a conceptual and an empirical level. We also discuss implications of our findings on student reactions. Specifically, we identify implications for the design of reflection activities, and we introduce the idea that engaging in student reactions to reflection activities could serve as a site of educator professional learning.

Literature Review

Papers from ASEE 2016 provide a sense of the role that reflection and reflection activities play in the engineering education community. For example, there are papers that describe a specific reflection activity done for a specific purpose: Niño (2016) talks about an autobiographical reflection activity to help students develop as leaders while Goswami and Walia (2016) describe how they have students reflect on mistakes during software inspections in order to improve their software inspection skills. There are also papers that describe collections of reflection activities that can be used toward particular learning goals. For example, Bankhead, Olmstead, & Mannard (2016) discuss a collection of reflection activities used to help entering engineering students prepare to function effectively in engineering education. Scholars also focus on how reflections can be used to gain specific insights into student understandings. For example, Cian, Cook, & Benson (2016) discuss collection of post-hoc problem solving reflections via audio annotations, and how such reflections can be used to explore students’ metacognitive strategies. On a cross-cutting level, Csavina, Nethken, & Carberry (2016) describe an investigation into students’ understandings of reflection in the context of design education--understandings that can be leveraged when designing reflection activities for students and/or introducing reflection activities to students, and Thomas et al. (2016) present a collection of suggestions for educators interested in adding reflection activities to their teaching.

This level of discourse suggests an opportunity to increase foundational, scholarly work on reflection. Scholarship to support the use of reflection in engineering education could proceed via multiple perspectives. For example, an expertise perspective might build on the work of Csavina, Nethken, & Carberry (2016) by looking more closely at the reflection abilities of engineering students. Scholarship leveraging an instrumental perspective might focus on how engaging in reflection leads to changes in distal performances or results in proximal knowledge gains. Finally, scholarship could leverage a phenomenological perspective by exploring students' experiences with and reactions to engaging in reflection. This latter perspective, with its focus on reactions to engaging in reflection, is interesting because it can provide guidance to efforts to design and redesign reflection activities.

Student reactions to reflection activities

We are interested in student reactions to reflection activities and are characterizing student reactions along two dimensions. The first dimension pertains to the valence of the reaction--the extent to which students feel positive and/or negative toward the activity. The second dimension has to do with the basis (or bases) of the reactions.

In terms of valence, it is easy to be drawn to the negative. In fact, a body of work in engineering education involves looking at resistance to active learning (e.g., Shekhar et al., 2015; Recabarren et al., 2015). In bringing the idea of resistance to reflection activities, it is interesting to note that there are understandable and even appropriate reasons for students to resist (e.g., the activity is too personal, the timing of the activity is poor). In the case of reflection and reflection activities, we believe it would be valuable to also look beyond resistance. If focusing on resistance is a form of deficit thinking, there is the opportunity to also look from an asset perspective (Valencia, 2012). Thus, we are interested in seeing the extent to which students are resistant to and/or resonant toward reflection activities.

In order to examine the bases of student reactions, we generated a preliminary reactions framework consisting of a set of possible bases for student reactions. The framework was created through literature review efforts. For example, the power basis (the last one in the list) is included because of works such as Ellsworth (1989) and Shor (1996).

1. **Cognitive basis.** Reflection requires cognitive resources. Students differ in the cognitive resources they bring. Sometimes resources are not readily available (e.g. attention or memory).
2. **Activity basis.** The design of reflection activities (e.g., the different features of an activity, the instructions, the sequences) might work for some and not others.
3. **Self-preservation basis**. Sometimes reflection can destabilize an individual's positions in ways that leave them feeling disoriented or vulnerable; sometimes it can help them preserve their positions.
4. **Cultural basis.** Reflection can run counter to an individual's sense of what is socially valued and reinforced; but can also be experienced as in alignment with social values.
5. **Epistemological basis.** Students can have pre-existing assumptions about the nature of knowledge as discussed in theories of epistemology development.
6. **Mindset basis.** Students can approach reflection activities with a fixed mindset or a growth mindset.
7. **Personal basis.** Students might have privacy concerns when sharing their reflections with others but could also appreciate having the warrant to do so.
8. **Instrumental basis.** Reflection may (or may not) be seen as being pragmatically useful in achieving one's goals.

9. **Situational basis.** Maslow's hierarchy of needs suggests that some people might have unmet needs that are antecedent to reflection. Others might have needs that can be met through reflection.
10. **Time basis.** The fast pace of modern life could mean a reflection activity is seen as a welcome opportunity to slow down or that there is no time for such slowing down.
11. **Power basis.** Students may not see teachers as having the authority to ask them to reflect. Some may welcome having reflection emphasized in a structured environment.

The reactions framework supports multiple insights. First, the framework illustrates the idea that, from a student perspective, there can be multiple reasons to experience resistance to and/or resonance with reflection activities. From an educator perspective, this framework illustrates the challenge of designing reflection activities. Further, this framework foreshadows how thinking about student reactions to reflection activities could function as a site of educator professional learning. If thinking about students' reactions to reflection activities involves thinking about issues such as epistemology, culture, and power, then such thinking might advance the educators' own understanding of such fundamental issues. How though, do we further explore these ideas? How do we collect data that might provide insight on students reactions to reflection activities? Before turning to our specific method, we provide background on the Consortium to Promote Reflection in Engineering Education. Work conducted through the consortium provided data for our analysis and also the basis of our interest in educator professional learning.

CPREE as a lab for studying reflection in engineering education

The Consortium to Promote Reflection in Engineering Education (CPREE) was established in 2014 to help engineering educators bring reflection activities into their teaching. Consortium members are 12 diverse campuses (4 research-extensive, 4 teaching-focused, and 4 associates-degree-granting), with dedicated PI scholars from a variety of engineering disciplines. During the first year, the campus PIs documented over 120 reflection activities.

Interestingly, the process of interviewing some of these educators became an opportunity for educators to talk about teaching and their philosophy of education (Turns et al., 2015). This observation has raised questions about whether, why, when and how a focus on engineering student reflection might function as a site of educator professional learning. For example, might a focus on student reflection help educators to (1) function as a critically reflective teacher (and "hunt for assumptions"), as described by Brookfield (1995), (2) grapple with significant questions of the field (e.g., questions related to engineering epistemologies, learning mechanisms, learning systems, diversity and inclusiveness, and assessment, such as described in Adams et al., 2008), and even (3) think about the multiple concurrent centerings that educational practice requires (i.e., learner-centered, content-centered, assessment-centered, community-centered, Donovan et al., 1999)?

During the second year, the goal was to promote more use of reflection activities. Educators on the campuses were encouraged to have students engage in reflection activities and, where possible, have students share their experiences through surveys. This effort resulted in over 60,000 student reflection experiences and survey data on around 3000 of these reflection experiences (for many reasons, surveys were passed along to only a subset of students).

Approach

In this work, we analyze open ended survey responses where students offered “additional observations” concerning reflection activities they had recently completed. These survey responses represent the perspective of undergraduate students at twelve universities and colleges across the United States. The dataset contains 1082 non-null responses. The analysis focuses on the following questions:

1. What does the data suggest about trends concerning resistance to and/or resonance with reflection activities?
2. What does the data suggest about the bases for resistance to reflection activities? The bases for resonance with reflection activities? How do the different bases manifest in the data? What is the alignment of observed bases for resistance and resonance with the preliminary ideas that sensitized the research?

During the data familiarization phase, a team of five researchers coded random samples of the dataset. This was done to determine whether the data could productively be coded with the reactions framework and to develop an approach for coding the data. This exploratory work confirmed that the survey data did afford exploration of the bases for student resistance to and/or resonance with reflection activities.

For this paper, the two co-authors subsequently coded all of the data (including recoding of subsets of the data that had been coded during the initial work). The responses were coded on two levels. On the first level, each survey response was coded as to whether it indicated resistance and whether it suggested resonance. A single response could be coded for both resistance and resonance. At the second level, each identification of resistance and resonance was then sub-coded using the reactions framework.

Consider the example from the title, “It is helpful but having it due a week out might be too long.” At the first level, this student response would be coded as both resonance (“it is helpful”) and resistance (“having it due a week out might be too long”). At the second level, the resonance coding would be sub-coded as instrumental (because of reference to the term “helpful”), and the resistance would be sub-coded as activity (because the identified issue has to do with a feature of the activity as designed).

In order to characterize the resulting levels of prevalence that a given code had in our dataset, we first counted the number of responses that had been categorized using that code by one or both of the authors. Using these counts, we then grouped codes into one of three frequency categories: high (>100 instances), medium (>50) or low (<50).

Results

Resonance responses outnumbered resistance responses. From the aggregated results, we found that 67.3% of the responses were positive, and thus evidence of resonance. Two major “bases” dominated our coding: instrumental and activity. *Instrumental* captured student comments about the reflection activity in relation to a goal. For example, instrumental-based resistances included “it didn’t do anything” and “I don’t feel that I actually learned some specific skills,” while instrumental-based resonances included “worth my time,” “useful in seeing what progress was made,” and “helpful to do in the future.” *Activity* captured student comments about the design of the reflection activity itself. For example, activity-based resistances included “at

times they were annoying" and "it was worded somewhat vaguely" while activity-based resonances included "the freeform nature of this activity led me to communicate using multiple facets" and "I like that it actually counted for points."

Because a comprehensive description of what we learned for each basis is outside of the scope of this paper, we focus the remainder of the paper on unpacking student reactions relative to three bases. We focus on student reactions that had *situational* bases because such reactions have a practical quality, and concerns can potentially be addressed easily. We focus on student reactions that had *epistemological* bases because of their potentially more challenging significance (e.g., addressing a student who does not appreciate the type of knowledge generated by reflection is more challenging than addressing a situational concern about timing). Finally, we focus on student reactions that had *connectedness* bases because connectedness was something that emerged through our coding effort.

Situational

We observed that 89 student comments described reflection activities positively or negatively in terms of how well these activities aligned with their personal situations. These comments, which we categorized as instances of the situational code, gave voice to student perspectives on how reflection activities can feel like they were 'just in time' or were complete non-starters depending on the situation of the student at the time. 24 of the 89 student comments expressed a positive attitude towards the reflection activity on the basis of the student's situation, while the remaining 65 were expressing a resistance to the activity. This suggests that students may be more likely to notice ill-timed compared to well-timed activities.

Students praised two things when their comments expressed a resonance towards the reflection activity on the basis of situatedness: timing and alignment. The most salient feature was timing with students making comments such as, "It could not have been better timed, I had just finished all of my tests so it was a great time to reflect on all of my midterms" and "The reflection activity was well timed. After a quarter of college, it can be easy for a student to regress to high school habits and lose their motivation to succeed. This activity reminded of why I want to succeed." The second feature was alignment; or when students expressed that the reflection activity gave them the chance to work on exactly what they had been thinking about. For example, one student wrote, "I do a small amount of reflection after each problem already this activity just made me quantify it."

Similarly, the 65 negative situational comments also focused on two issues: timing and existing workload. For instance, one student commented, "The weekend this assignment was assigned was already a busy one and having an assigned, but ungraded assignment, felt like unnecessary added work". Another wrote, "I wish we had done it earlier in the quarter, like maybe after one of the exams". However, occasionally comments also touched on other issues, having to do with the student's unique and situated challenges. For instance, students wrote about how language barriers could make the reflection activity feel more difficult for them: "For the first place, this hard for me to do it because I am not fluent in English but when Ms. [snip] help me, I can work with my essay do well."

Epistemology

A significant number of comments in our dataset described reactions related to what had been learned through the reflection activity from the student perspective. 239 of these comments were coded by us using the conceptual category of epistemology on the basis that they lent insight into the authoring student's assumptions about the nature of knowledge.

Of these 239 comments, 203 were about the student expressing positive feelings towards the reflection activity that they had engaged in because the activity had placed particular value on the kind of knowledge that was involved. One type of knowledge that students resonated with had to do with metacognition or learning about learning. This was succinctly captured in student statements such as: "Good for students to observe their mental states and work habits during assigned programs," "The activity was effective and allowed me to better observe the flaws in my study habits" and, "I think this helps me and the teacher in order to understand my brain and learning style. It also helped me to stayed encouraged that i can do better and i can learn what works in testing for me and what doesn't." Statements such as these highlight the value that some students find in activities that surface the 'muddiest points' in their own learning.

Several student comments also placed emphasis on a more personal kind of self-knowledge. For instance, some students wrote about how reflection helped them with their 'big picture'. Particular examples of such student remarks include: "The activity showed me what are priorities in my life, education and my career", and, "..This activity reminded of why I want to succeed". Some students linked this type of learning to resilience and being critical thinkers. For example, one student wrote, "I liked this activity because it forced us to reach out to our network of people and realize what are true strengths are." While another remarked that, "It was also great to think about the values I've grown up with and those I've takes as my own."

On the other hand, 36 student comments expressed a resistance towards the reflection activity on the basis that the student did not see the knowledge being constructed through the activity as valuable (or even as knowledge at all). For instance, in contrast to previous comments, one student wrote: "Did not seem to be important to anything I see in the future," while another more emphatically expressed, "I DON'T FEEL THAT I ACTUALLY LEARNED SOME SPECIFIC SKILLS". And in a similar vein, another student asked, "Why do we do these, nobody learns anything from them and they are simply taken for busy work and are often incredibly confusing and vague in directions." Collectively these comments foreground the variations in students' epistemological stances.The latter comment also speaks to the blurring between epistemological and cultural bases. The statement not only refers a lack of knowledge resulting from reflection activities, but gives voice to the student's understanding of cultural norms (i.e. "nobody learns" from activities that are generally "taken for busy work").

Connectedness

We observed a type of student comment in the data that did not readily map to any of the bases articulated in the reactions framework. These were comments (84 total, 69 as resonances, 15 as resistances) that cast the reflection based on how well the activity functioned to create *connections* between the student and others.

As a resonance, students viewed the reflection activity as a positive pathway to deeper connections such as through conversations. This sense of finding deeper connection was often

expressed in relation to the educator. For instance, one student who felt more connected to the educator wrote: “It was cool. My professors have asked sometimes about how we feel in our own progress, but usually toward the end of quarter. It was nice to have a full term of activity to keep up, and also have so much open communication with the professor.” Other student comments address this same idea by further describing the quality of the communication or what those qualities seemed to enable. For instance, one student wrote: “helped me portray my feelings about the project to my professor.” This demonstrates an emphasis on emotions related to the project, which can be difficult to elicit or work with in traditional circumstances.

A positive sense of connectedness also involved fellow students. Student comments suggested appreciation of the inclusiveness that their educator’s reflection activities created: “I liked how activities like this involved most people in the classroom” and “It went smoothly and was nice listening to the reports from other students going through the same problems!” Similarly, some students remarked that their reflection activities promoted teamwork: “this is something that should be incorporated into every degree plan across the united states to emphasize teamwork in all college graduates”.

As a resistance, comments were generally an expression of disappointment for lack of connections and communication. One student captured this with the comment: “It was pretty quiet, I thought we'd talk more with others.” Notice that this student might have been given a more contemplative experience, but actually desired collaboration or connection. Touching on the role of feedback, one student remarked: “I wish that we would have discussed the reflection briefly after turning it in.”

Discussion

In this paper, we have used survey data to illuminate three bases for reactions students may have to reflection activities. Two of these bases had been identified by our research team prior to the analysis; the remaining basis (connectedness) emerged from the analysis. Our data is likely to underestimate the prevalence of the issues we have identified since students were not required to take the survey and offered only what was on the top of their mind (as opposed to a comprehensive sense of their reaction). Methodological creativity will be needed to further explore student reactions to reflection activities.

In future work, we will explore issues related to coder agreement such as the level of agreement that may be possible given the data source and the interpretive nature of the coding. Additional development of the reactions framework will help resolve coder disagreement. In addition, there is a need to address the overlapping nature of the issues representing the framework, such as the blurred boundary between epistemological and cultural bases for resonating and/or resisting reflection activities. A next step may be to move beyond a list in order to show the relationships among these ideas.

Implications for Practice

Here we touch on two types of implications for practice - the practice of using reflection activities and the practices of educator learning. In other words, we address the questions: (1) what might the overall pattern of resistance and resonance, as well as the observed bases for resistance and resonance, suggest for successfully leveraging reflection activities in engineering education and (2) what do our observations suggest about why “engaging students with reflection” might

function as a site of learning for educators themselves? What types of educator learning might arise through work with reflection activities?

Concerning the practice of using reflection activities, the findings about the situatedness of reflection activities serve as a practical reminder to take into account the mundane when asking others to engage in any task. In this case, taking into account practical situational issues by students may be important for helping students engage with reflection. Our findings concerning students reactions on an epistemological level are more difficult to see as immediately actionable, although they are worthy of discussion. Finally, our findings about the role of connectedness in student reactions to reflection is reasonably actionable; the findings suggest that reflection activities that help students feel connected may be more successful.

It is the possibility of such discussion that brings us to the issue of educator professional learning. Indeed, as we (the two authors of this paper) discussed the issue of epistemology as it relates to reflection and engineering student learning, we found ourselves seeing engineering student learning, engineering teaching, and the role of reflection in different ways. In general, as our reactions framework suggests, the different elements of students' reactions to reflection activities are fundamental issues to educator learning. Furthermore, because reflection activities operate on the fringe, the issues may seem more "open" for discussion. For example, while it may arguably be critical to think about the epistemology of engineering, such a conversation may not seem necessary when we "know" that students need to learn theories and do homework problems and take tests. But, when reflection activities come into the picture, there is more room for discussion. Moreover, having such conversations in the context of reflection activities may also be "safer" since reflection activities may feel more experimental. Also, having such conversations in the context of reflection activities may engender more willingness to explore other strategies.

Conclusion

Although the use of reflection activities in engineering education is of interest, the understanding around student reactions to reflection activities remains largely unexamined. The contribution of this work is to empirically describe three bases (two pre-identified and one emergent) for reactions that students may have to reflection activities. Future work can focus on empirical descriptions for other bases as well as extending our analysis of the three bases that we present in this work. Implications of our results for educators include addressing the instrumental value of the reflection activity up front and carefully designing reflection activities to acknowledge situational considerations.

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