Community Perspectives on Chemical Engineering Education

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Community Perspectives on *Chemical Engineering Education*

Abstract

This study investigated faculty perceptions and needs salient to the future of the journal *Chemical Engineering Education* (CEE). Specifically, we sought to understand (a) how faculty use CEE and what they value about it; (b) barriers and improvements to publication and use; and (c) perceptions of the "Diversity, Equity, and Inclusion Consideration Requirement," which began in 2021. To guide this work, we posed the following research questions: 1) What is the perceived utility of CEE? How do faculty use CEE? What do they value about the journal?; 2) What are the opportunities for improvement? What barriers preclude publication and use?; and 3) What are the perceptions of the "Diversity, Equity, and Inclusion Consideration Requirement," which began in 2021? We also analyzed the data for an overarching question: What values, attitudes, and beliefs do chemical engineering faculty express about practitioner-focused and discipline-specific education research publications? We conducted focus group interviews representing different CEE constituents (e.g., those who read but have not published, those who have published often) and represented varied perspectives (professional track, tenure track, tenured, varied institution types). As a first step, we report the analysis of a set of five focus groups, including 12 faculty members total. We found that many faculty appreciated the practical nature of the journal for its capacity to offer inspiration for teaching and widespread impact. When asked about the DEI requirement, some faculty raised concerns, being careful to express that they valued DEI, but showing uncertainty about how, for instance, a description of a laboratory experiment could meet this requirement. This discussion suggests a need to support authors publishing under the new DEI guidelines. In this paper, we summarize some of the initial findings from this work and also seek to continue and broaden the conversation with the community through presentation in the ASEE Chemical Engineering Division.

Introduction

Chemical Engineering Education (CEE) has served education practitioners from the chemical engineering and related communities for 60 years. However, over that time span, the landscape of education scholarship has shifted. Engineering education research has emerged as a legitimate form of academic scholarship [1]. Meanwhile, many chemical engineering programs have shifted to greater emphasis on research productivity, and professional track faculty have emerged as an important resource in delivering high quality instruction to larger and larger class sizes [2]. Additionally, new challenges continue to face the field, including shifting undergraduate enrollments [3], the need to prepare graduates to use new technologies and address emerging directions in the field [4], and continued calls for an engineering education that leverages research-based practices and supports equity [5,6].

In light of this changing landscape, an *ad hoc* committee was appointed by the CEE Editor and Publications Board to evaluate if the current journal structure is best serving the needs of the community at the present time and projected into the future. This community includes the current constituency of authors, reviewers, and readers, as well as potential community members who currently use other publication venues. The authors represent members of the committee with various levels of engagement with CEE, including Publications Board members, editorial staff, active authors publishing in CEE, and those with no previous activity at the journal.

Based on this charge, the committee formulated a set of goals and protocols to gather a broad set of data to understand how the journal currently is positioned within the community and what needs are and are not met in the current journal format and offerings. In this paper, we present the results from focus groups collected from the community at the 2022 American Society for Engineering Education (ASEE) Annual Conference & Exposition and the 2022 ASEE/American Institute for Chemical Engineers (AIChE) Summer School. The Summer School is a week-long professional development opportunity with the goal of providing practical tools to get faculty rapidly and securely on track for a successful career in academia.

We paid particular attention to qualitative data that reflected participants' values, attitudes, and beliefs and represented their perspective or worldview on chemical engineering education. We follow Saldaña's [7] definitions: a *value* is the "importance we attribute to oneself, another person, thing, or idea" [p. 89]; an *attitude* is the way that one thinks or feels about those same targets; and a *belief* is a system that encompasses values and attitudes with the addition of personal knowledge, experience, and other interpretive perceptions of the world. In this work, we emphasize values as ideas that participants *situationally* ascribe importance to; attitudes as more enduring and used to evaluate situations; and beliefs as "rules for acting." This focus provided a way to not only evaluate the key actions and ideas described as opportunities or challenges associated with CEE but also to understand the perceived value and value systems associated with the journal and chemical engineering community.

Research Questions

Our analysis of the focus groups was guided by the following research questions:

1. What is the perceived utility of CEE? How do faculty use CEE? What do they value about the journal?
2. What are the opportunities for improvement? What barriers preclude publication and use?
3. What are the perceptions of the Diversity, Equity, and Inclusion (DEI) Consideration Requirement which began in 2021?

We then interpreted responses to each question with the overarching question: What values, attitudes, and beliefs do chemical engineering faculty express about practitioner-focused and discipline-specific education research publications?

Methods

We used a descriptive, qualitative research approach to explore how CEE is currently positioned within the community. This research methodology is "not guided by an explicit or established set of philosophic assumptions in the form of one of the known qualitative methodologies" [8, p. 2]. Instead, this methodology provides a flexible approach to gather qualitative data centered in the phenomenon of interest.

As a starting point, we used focus groups to gather information from the community. We chose focus groups as they provided a space for shared conversations among the community about CEE and provided ways for participants to build on each other's responses. The data gathered are a means to elicit the "the rich details of complex experiences and the reasoning behind [an individual's] actions, beliefs, perceptions and attitudes" [9, p. 499,500].

The focus group protocol (Appendix A) was developed by the committee to gather a range of input on the strengths, opportunities, and use of the journal. This protocol included seven questions and was guided by focus group practices to start with engagement questions to introduce participants and make them comfortable with the topic of discussion. Then the protocol moved to exploration questions to probe the phenomenon under inquiry. The protocol ended with an exit question to provide an opportunity for additions and check if anything was missed in the discussion.

Participants were recruited via announcements through the ASEE Chemical Engineering Division, ASEE Educational Research and Methods Division, and the AIChE Education Division. Recruitment was also shared via the Slack channel for Summer School participants. We asked these individuals to complete a short screening survey to provide information about their availability for scheduling, institutional affiliations and roles, and prior experiences with CEE. A total of 12 individuals who responded to the recruitment efforts were available in-person. Seven of the participants were tenure-track/tenured, four were teaching/clinical, and one was a graduate student. Participants came from four private and eight public institutions. All subject consented to participate in this research, approved by the Purdue University IRB (IRB-2022-685).

We grouped individuals into focus groups by availability and by prior experiences with CEE (i.e., those who have published in the journal and are actively engaged in the community, those who have published in the journal and who occasionally read the journal, and those that have not published in the journal). These groupings provided commonality among focus group members to facilitate discussion. The committee conducted three 30-minute focus groups at ASEE and two 30-minute focus groups at Summer School with two or three participants in each group. Each focus group was moderated by one or two members of the committee. The groups were intentionally small to accommodate a 30-minute scheduling block during the busy conference schedules so that everyone's voice could be heard.

Following norms in qualitative research, a sample size of even one can be adequate, depending on study aims and authors' epistemological stances [10]. Even by positivist standards, a sample of 12 is sufficient for reaching saturation, unless the phenomenon is complex and highly varied [10, 11], which is not the case in this study.

The focus groups were audio recorded and transcribed. The committee divided the focus groups among the team and thematically coded them for strengths and opportunities as well as espoused values, attitudes, and beliefs as a first cycle coding method [7]. In applying this coding approach, our intention was not to classify each statement reliably as a value, attitude, or belief, but rather to take an expansive stance on the perceptions shared, and across categories. Several group meetings discussed codes for consensus and meaning. Filler words were removed from quotes and in some reported quotes, some words were added for context and clarity. These additions are noted with brackets.

Findings

Findings are reported that address each of the three research questions: (1) utility of CEE; (2) opportunities for improvement; and (3) response to the recent DEI requirement. In the first two,

participants offered varied responses, though no theme was mentioned by only one individual. To share the breadth of themes related to the first two research questions, utility and improvement, we share the themes, illustrated by example quotations. These are followed by the committee's interpretation of the values, attitudes, and beliefs that are implicated. Participants' responses to the DEI requirement were more cohesive; accordingly, we present these in a more concise format.

Utility of CEE

Table 1 provides the major themes associated with the useful aspects of CEE described by the the focus group participants. Themes included helping themselves and others with instructional practice, building community and supporting their growth as scholars, and the accessibility of content in the journal.

Table 1. Themes and example quotes for Research Question 1.

Theme	**Examples**
Helps with ChE discipline-specific instructional practice *[Belief]*	"[Authors] share research-based, classroom-tested, ChE teaching innovations." "[Authors] communicate things they have tried, what has worked, what hasn't."
Helps support others in their instructional practice *[Value]*	"There could be articles in there that [I am] very comfortable sharing with a colleague who maybe isn't involved in the scholarship of teaching and learning in some way, but could see very practical things they could put into their courses."
Builds community and supports identity as an education researcher *[Attitude]*	"My validation as an engineering educator was through publications in this journal." "I like the profiles of the people" and 'personal touch' in educator profiles."
Nurtures scholarship capacity *[Belief]*	[The] "Editor was gracious and, and helped me get through it and get [...] published there." "I've gotten just as much like feedback on teaching tips and used, applied those as I have from the full article."
Provides content that is accessible and comprehensible *[Attitude]*	"So I read the articles in [two other journals cited]. Those are so much education focus[ed], and some of the things are really hard to grasp. But when I look at CEE, it's very practical and everything that I see there, I can easily apply into my classes. I can easily reach out to most people."

Values, Attitudes, and Beliefs

The focus group participants clearly expressed the attitude that CEE has played an enduring role in the chemical engineering community, both historically and currently, with one participant describing CEE as a "needed place." Several participants expressed the value that CEE was a useful source of ideas for lessons, courses, and programs that faculty members can use in instruction and share with colleagues. They also expressed the belief that the journal, as a peer-reviewed resource for content that is specific to the discipline, is used in practice, citing that, "it serves a really important role as both a research and a practice journal." In addition, they noted

that CEE is discipline specific and has content that is accessible. Several participants shared the attitude that an important feature was that CEE provided conceptually accessible materials to improve their teaching, in contrast to other “high-level” education journals, viewing those as "not that practical" since they were more difficult to understand.

Through the focus groups, a dual role for CEE emerged: (1) CEE provides a useful resource for discipline-specific content that can be used in practice; (2) There were also ideas put forth that CEE should continue to raise the quality of assessment towards a higher level of scholarship. That is, CEE was viewed as a potential resource to develop a "higher level of understanding about educational change models and the assessment and the evaluation." These dual goals could potentially be supported by distinct practice and research sections.

CEE is valued for its role in building the chemical engineering education community and supporting individual trajectories as education scholars. This nurturing role is undergirded by a complex set of values, attitudes, and beliefs that the chemical engineering community holds — namely, that we value teaching as well as research that benefits our teaching. CEE provides an accessible way for educators to connect, as authors attend common national conferences (e.g., AIChE or ASEE), so interested people can readily interact. CEE makes it feasible for newcomers to publish, and the review process provides substantial feedback to learn from. However, there could, potentially, be more support to develop knowledge and skills needed for this type of scholarship and as a nexus for community building, as a whole.

Opportunities for improvement

Table 2 provides the major themes associated with the aspects of CEE that could be improved. These included practical issues related to journal access and structure as well as issues tied to the broader structures and norms of the discipline that the journal serves.

Table 2. Themes and example quotes for Research Question 2.

Theme	Examples
Practical considerations	
Difficult to physically access and to find and sort specific content when searching	"Most of the time the library doesn't even know we have […] access to it." "Sadly there's no abstracts. I would say that's […] a […] major minus to the journal [since] that abstract is […] how you determine if you wanna read that whole article."
Indexing	"A huge hurdle [is] indexing. But I think just being indexed by any major database would be really, really helpful because, you know, some, I publish some of my stuff in the international journal, *Education for Chemical Engineers*." "It [not being indexed] just distinguishes it in a bad way from all of the journals I read. Right? And from indexing and from web searching and, and all the [...} metadata kind of stuff. That's a huge minus right now." "It's not indexed by Web of Science."
Values, attitudes and beliefs	
Some types of articles are perceived as more useful than others *[Attitude]*	Review articles or collected content: "It'd be nice to see more of that and kind of just like when I review [an] article, the benefit is instead of having to go to all the individual articles and piece them all together, someone's done that work for you already" Book reviews: "I'm not sure book reviews are useful anymore."
Lack of resources, prior experience, or support for publishing *[Value]*	"Maybe some sort of […] workshop on […] how to do educational research or engineering educational research, specifically as somebody who hasn't had that. But there's a lot of other resources that do that, that doesn't need to fall on CEE specifically." "I didn't start [in] engineering education research before, and [...] I wasn't really aware of […] CEE. So that's why I was kind of [hesitant to] do any research in my class or publish it."
Perceptions of technical vs. education scholarship in tenure and promotion *[Belief]*	"I don't think for the tenure track faculty, it would be valued at the same level, so they're not really jumping in to do it." "If I don't publish [in] engineering education, […] it won't be held against me. So I think that the incentives are still for me to publish more on my research and the lab than engineering education."
Broadening the readership to students and early career researchers *[Attitude]*	Wish CEE "was on the radar of graduate students, postdocs, and/or early career faculty sooner." "I kind of wish it was marketed more towards […] PhD students or even like undergrads who might be interested 'cause I didn't know it existed until I […] was actually teaching already."

Values, Attitudes, and Beliefs

The focus group participants highlighted opportunities to directly improve the experiences of CEE readers and authors. In addition, there were comments that addressed the culture of the engineering community more generally which, although not directly related to CEE, could provide an opportunity for CEE to exert influence.

Participants expressed that CEE content is valuable for educators, but it is not always easy to physically access current articles due to the publication model. In addition, it can be challenging to quickly locate specific content of relevance. While there exists a search feature, participants expressed a desire to have content explicitly organized on the website in ways that aligned with their interest, such as by core course or pedagogical approach. For example, if you were teaching reactor design, the site would directly point to a collection of papers on that topic, and similarly, for pedagogical approaches like flipped classrooms. To take this idea further, CEE could encourage submission of reviews that compiled content from published articles. Participants also expressed the need for indexing so their work is more visible and publication aligns with evaluation metrics such as promotion and tenure.

Participants expressed the attitude that CEE is relevant for an audience beyond its current reachand suggested initiatives could support development of faculty who want to do this type of work would be useful. They noted this need especially for those at institutions where they feel isolated [12] and as a resource to mentor graduate students and postdocs, as well as for chemical engineering graduate students to support their ability as TAs, and even to undergraduate students to support their journey as learners. Such activity could result in engaging potential engineering education researchers earlier in their careers. In summary, they wondered what role CEE could play in leveraging our community to support one another and elevate the work.

Participants expressed the belief that publishing in CEE often has a different level of importance based on institutional culture and promotion guidelines. For tenure-track faculty, there may be little to no recognition nor incentive to publish in engineering education journals, and while teaching-focused professional-track faculty often see more value in such publications, they are not always afforded the resources or training to contribute. Hence, some may be reluctant to get involved in engineering education scholarship.

Perceptions of the DEI requirement

Beginning in 2021, CEE added a requirement that all papers consider their "work through a DEI lens." To support authors, a one year transitional option was offered in which authors could discuss DEI in their cover letter instead of in their paper, and papers and editorials offered additional guidance [6, 13]. As detailed in an editorial, this change was prompted by Lisa Benson's comments at an ASEE presentation about how journals can play a role in DEI [14]. Using the values, attitudes, beliefs approach to analysis, we can characterize a developmental trajectory suggested by this requirement. Specifically, while many authors might hold situationally ascribed values that DEI is important, many may not take this value up as an enduring attitude or a belief that guides their actions as they plan studies, develop learning experiences, conduct analysis or evaluation, and communicate their results. By adding the DEI requirement, CEE inserted a "rule for acting" that might prompt a more enduring consideration

of DEI, but such a response may take time. This conjecture in turn prompted our inquiry into participants' reported values, attitudes, and beliefs about the DEI requirement.

All participants expressed DEI as a value, meaning they considered it to be at least situationally relevant (Table 3). For some, the situations in which DEI seemed relevant were limited, such as to those whose research focused on such topics. Others embraced the DEI requirement also as an enduring attitude, favoring the requirement as more broadly promoting awareness of DEI issues. A few expressed DEI as a well-developed belief, sharing specific examples of ways they used the requirement as a rule for acting. Far more commonly, participants expressed a nascent—sometimes optimistic, sometimes skeptical—belief of how the DEI requirement could shape authors' work. We interpret the different stances expressed as representing different places on a DEI trajectory; thus, with adequate support, those who hold DEI as a value may discover ways to incorporate DEI as an enduring attitude or belief/rule for acting. We conclude that CEE's new DEI requirement has prompted authors to think about how their work has or could have a DEI connection, but persistence and support are needed to help faculty develop from viewing DEI as a situationally relevant value to a well-developed belief.

Table 3. Themes and examples of values, attitudes, and beliefs about the DEI requirement.

Theme	Examples
DEI as a situationally-relevant value, but not as an enduring attitude or belief	"While I agree with the spirit of that, I don't think that's accomplishing what that's going to accomplish, what it intended to." "From my viewpoint to me, it would almost be better if it were a strong encouragement, an emphasis, but not a requirement. [...] If there's anything you can say about about DEI in your paper, we would love to see a section on it, [...] but we acknowledge it may not fit every paper directly. [...] I can't see how estimating mass transfer coefficients from the weight of candy over time. I just can't. It's hard for me to picture where I'd have a section. [...] I just don't know where that would come in or how that would be relevant."
DEI as an enduring attitude	"I think it is a good thing to have top-of-mind." "So I really like stating it and saying that explicitly, [it] helps us to get the awareness better." "I love it. [...] I think it's terrific."
DEI as a nascent belief / rule for acting, skeptical	"I find it confusing, right. There weren't really any examples or ways you could do it. [... A reviewer said, 'you] reported the gender breakdown of your class, but didn't talk about it.' I was like, okay, that's true. [...] Is that enough? Do I need to do more than that? [...] It's very vague to me." "I like it, but I'm worried it'd be performative for a lot of people, that they're gonna do their work, and that at the end, they're gonna be like, oh crap, 'I gotta like quickly make something up,' as opposed to it being like ingrained in their research questions."
DEI as a nascent belief / rule for acting, optimistic	"How does what I'm implementing affect different populations? [...] They all come in with their different backgrounds. [...] Not everything's gonna work for every student every time. [...] Being cognizant of like, I'm not [...] making things worse for people. [...] So I think maybe having that more upfront, [...] 'cause it would be awful to get to the very end of a semester and not even think about that." "I think everyone tries to do that, but if it's made more explicit, then it kind of becomes a norm." "It could open the door for a conversation about 'Have you thought about this aspect or could you clarify these pieces?' [...] It's used to make the authors be thinking about those on their papers as well."
DEI as a belief / rule for acting	"My examples [in sharing curricula] are not just North American or European." "And I've used it as an argument with the P&T. My university's P&T committee was going back and forth [...] 'Gee, do we need a thing?' And I was like, 'My journal has! So I'm writing about something completely that isn't focused on this, and I have to address it in some way, while I'm talking about cake for crying out loud.' We can force every professor in the university to say something about how they've contributed to DEI."

Discussion

The focus group interviews provided a first step in gathering information towards making a recommendation about ways CEE is serving the community, including current participants and potential new participants. The overarching question is, "How does the structure of the journal

impact who it serves and potentially serves?" We present here the committee's initial findings related to the structure and operation of CEE in terms of the journal's utility and opportunities to better serve the community and considerations of the recent DEI requirement.

Utility and Opportunities

Across focus groups, participants expressed what appeared a genuine fondness for CEE and expressed gratitude for the "needed place" it provides for chemical engineering educators. The journal serves practical needs, helping faculty with their instruction and other educational work in ways that focus on discipline specific content that are comprehensible. CEE also provides a resource for them to help other faculty members. They also appreciated the role CEE serves in supporting their participation and growth as scholars of teaching and learning. There was a more general attitude expressed that CEE formed an important hub within a disciplinary community around chemical engineering education.

There appears to be a dual role that CEE fills, (1) providing archived instructional materials and practices and (2) as a venue to publish educational scholarship and to support individual recognition of this work as a legitimate form of scholarship. The committee recommends examining structures to support this dual role, perhaps with practice and research sections. More broadly, CEE should consider ways that it can serve a greater purpose than archiving and disseminating content and practices and build on its sixty-year history to actively be a community hub in supporting the community's capacity for educational practice and scholarship, such as by sponsoring workshops and more intentionally positioning itself at conferences. Such a vision is consistent with changing ideas about the role of publishers in the 21st century.

Several more specific, practical recommendations also emerged from the focus group. First, the journal should work towards making published articles more visible through indexing. Second, there may be ways the website can provide extra organization to help busy educators more quickly find related content. There was also expressed a need for review papers that consolidated understanding within a content area or for a particular pedagogical approach. While the journal has a loyal core readership, CEE may want to consider strategies to increase that constituency, including current graduate students, early career scholars, and maybe even undergraduates.

DEI Requirement as Support along a Trajectory

While there may be other perspectives on CEE's DEI requirements that were either not held by our participants, or due to social desirability, not expressed by them, the values, attitudes, and beliefs identified in this analysis, especially when considered with the broader perceptions about CEE, suggest a developmental trajectory and educative role for CEE. This DEI developmental trajectory begins from a place of valuing DEI within constrained situations; for instance, faculty may express that DEI is needed, but not typically salient to their own work. From here, faculty may evolve to understand DEI as omnirelevant, holding DEI as an enduring attitude, a stance everyone is responsible to hold. In our analysis, we differentiated two variants at this point—a skeptical/uncertain stance and an optimistic stance. From here, faculty may shift to DEI as a belief that guides action. Yet the gap between holding DEI as an enduring attitude—especially an uncertain or skeptical stance—and using DEI as a rule for acting is wide, suggesting a need for scaffolding.

Just as CEE plays a role in supporting chemical engineering faculty along a trajectory of adopting research-based teaching practices -- from tinkering with their own teaching innovations and practices to evaluating their impact on learning and engagement to then sharing the results with the community-- CEE could offer more support for faculty related to DEI. With a developmental trajectory in mind, we suggest the following DEI supports, though also anticipate that additional feedback and evaluation will expand and refine this list:

- A curated set of papers that provides accessible frameworks about power and explanations for currently preferred terms, whether published in CEE or elsewhere [6, 13, 15].
- Exemplar papers that are not *about* DEI, but that treat DEI as omnirelevant, such as by explaining the limitations of a study sample that does not include students from minoritized groups.
- Examples of how the various types of CEE papers address the requirement.
- Opportunities to consult with editors about ways to meet the requirement.
- Webinars or workshops at conferences that offer worked examples/walkthroughs of ways to meet the requirement.

In addition, while CEE and we have used the acronym DEI, we note that it is increasingly common to include justice, often with the acronym JEDI or DEIJ. Bringing attention to justice matters because it orients us to consider both the outcomes for our students and the structural barriers some students systematically encounter because of their race, ethnicity, gender, and/or disability [16]. Even the recent National Academies report, *New Directions for Chemical Engineering*, and the Engineering One Planet Framework bring focus to both environmental and social justice [17, 18]. As critiques have been raised that the acronym JEDI carries cultural meanings that misalign with the aims of justice [19], the committee recommends that CEE update its language as "DEIJ requirement" and include resources—in addition to the National Academies report and EOP framework -- that offer guidance on ways justice can be a focus in CEE publications [e.g., 20, 21].

Next Steps

More broadly, as we continue examining the structure of the journal, we plan to collect additional information to integrate into the analysis, including:

- Developing a survey based on the focus group analysis for distribution to the broader community.
- Mapping the historical (past, future) trajectory of scholarship within CEE.
- Analyzing journals in chemical and biological sciences and engineering that publish discipline-based education research (DBER).
- Identifying and analyzing previous data collected about CEE.

The authors encourage any feedback that may inform this future work.

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Appendix A - Focus Group Protocol

1. Can you please introduce yourself, including your institution, role, and why you signed up for this focus group/interview?
2. Please comment on your overall impression of CEE.
3. Some people might use CEE to get ideas for their teaching, some might use it to get ideas for research, some might use it in other ways. How do you use CEE? Do you use other journals like CEE? What journals? In what ways?
    a. If so, which types of articles are most helpful?
    b. Have you been able to directly apply something you've learned from a CEE article?
4. Have you published in CEE? Why or why not?
    a. Does your work/employer value publishing in journals like CEE?
    b. How is publishing in the scholarship of teaching and/or education research perceived for your career/promotion?
5. How could CEE change to be more compelling for you to publish in? to read?
    a. [time permitting] Are there particular resources that would better support your engagement with CEE (i.e., training materials, mentoring resources, etc.)?
    b. [time permitting] What barriers do you think other chemical engineering faculty face in publishing an education paper?
6. The current submission checklist includes the recent addition, “Your submission (with relevant citations) addresses **diversity, equity and inclusion** issues within the body of the work, as a separate sub-section of the work or within a letter of submission.” What are your thoughts about this requirement?
7. Is there anything related to CEE that you want to share, but we have not asked yet?