Revealing teaching conceptions and methods through document elicitation of course syllabi and statements of teaching philosophy

Dr. Natascha Trellinger Buswell
Department of Mechanical and Aerospace Engineering
University of California, Irvine
Irvine, CA, USA
nbuswell@uci.edu

Dr. Catherine G.P. Berdanier
Department of Mechanical Engineering
Pennsylvania State University
University Park, PA, USA.
cgb9@psu.edu

***Abstract*— With poor teaching quality being of concern in higher education in engineering, this Full Research Paper seeks to investigate an interview approach that aims to gain insight into an instructor's teaching methods and conceptions. This interview approach is called document elicitation, a method based on the interviewing approach of photo elicitation. Understanding an instructor's teaching conceptions and methods is useful in gaining insight into how and why people teach. Using document elicitation during an interview with two documents, 1) course syllabi, and 2) statements of teaching philosophy, this paper reports on the generative descriptions of teaching a syllabi and statements of teaching philosophy offer in a document elicitation setting. Semi-structured interviews were conducted with twelve assistant professors of engineering. The analysis focuses on the document elicitation portion of the interviews. Inductive-deductive thematic analysis was used to develop a codebook of teaching conceptions and methods. The paper reports on the teaching conceptions and methods that the participants describe, including active learning techniques, inclusive practices, and challenges. This paper may particularly interest people who conduct interviews for research and/or hiring purposes. Document elicitation as part of a hiring interview seems promising as a way to learn about a candidate's teaching conceptions and methods.**

Keywords—teaching conceptions, teaching methods, document elicitation interview technique

I. INTRODUCTION

Teaching methods and quality are of concern in higher education [1][2] and engineering education communities due to the slow adoption of evidence- based and active learning approaches, even those that have been demonstrated to provide better learning outcomes for all students, and especially for students of marginalized and underrepresented backgrounds [3]. We know that active-learning approaches (those requiring students to construct their own knowledge through discussion-based pedagogy, rather than via lecture) are not rapidly adopted by instructors, and the reasons for the low adoption rate include lack of alignment between promotion requirements and the value of teaching [4].

Best practices in pedagogy have been studied for decades and are not new to the discipline of engineering education [5][6][7][8]. With the rise of active learning practices, and evidence that suggests these practices better serve many populations of students [3], teaching is starting to play a more central role on campuses in various ways. Most U.S. institutions have centers devoted to teaching and learning (some being discipline-based, serving Colleges of Engineering, for example), many are creating classroom spaces that are conducive to active learning practices [9], numerous professional development opportunities exist to support the use of evidence-based practices [4], more diverse evidence of teaching effectiveness is encouraged as part of promotion materials [10], and discussions about teaching, including teaching demonstrations, are sometimes being included faculty interviewing [11].

Teaching conceptions, which are the values and rationales that instructors hold that guide teaching practices, are less studied. While most literature discuss elements of good pedagogy that is relatively disciplinary, the purpose of this paper is to understand conceptions of teaching within the field of engineering—which undoubtedly struggles to incorporate pedagogical best practices due to large class sizes, content requirements, student and faculty resistance, and disciplinary expectations [12][13]. Because of the paucity of research, we turn to Light and Calkins's [14] conceptualization of teaching orientations to describe two ends of a spectrum of teaching conceptions, where:

> "The first orientation describes faculty who are concerned with teaching as, essentially, an organization of the content of the teacher's knowledge for transmission to the students. The second orientation describes those who regard teaching as facilitating students' personal construction of knowledge and conceptual change."

Numerous other studies about conceptions also focus on positive practices of "good" teachers, from which we can learn. For example, Borgford-Parnell [15] developed the "pedagogy of larger concerns" based on a study done with excellent teachers who have won teaching awards. Borgford-Parnell identified five conceptions about teaching: 1) teacher's power is leavened with responsibility, 2) students are synonymous with positive vision of future, 3) learning to learn takes precedence, 4) teachers are essential to student learning, and 5) new learning fits to the student's lifetime of learning.

These findings correlate with the few studies of engineering faculty conceptions. McKenna et al. [16] found six strategies engineering instructors employed in their teaching to aid in student learning: 1) recognize difficulty in learning subject matter, 2) steadily increase the level of complexity and make connections between concepts, 3) contextualizing the information: give real-world examples, 4) use multiple representations, 5) make personal connections, and 6) encourage interaction.

In light of the need to better understand the teaching methods and conceptions of engineering instructors, this paper reports on a study in which we examined the use of an interview technique called document elicitation, based on Harper's [17] photo elicitation, where interviewees describe and reference their course syllabus and statement of teaching philosophy as part of the interview. The research question that guided this work is: **In what ways do assistant professors of engineering conceptualize their roles and decisions toward teaching decisions?**

The present study adds to the literature in several ways. First, the studies done previously to identify teaching conceptions have been conducted with "excellent teachers," often those with decades of teaching experience, rather than gathering snapshots of teaching conceptions from more average faculty and/or those at the beginning of their careers. Furthermore, the literature on methods to best evaluate teaching and teaching philosophies or conceptions remains scarce. The study presented in this paper also shows how this document elicitation interviewing technique using course syllabi and statements of teaching philosophy provides useful insights into an engineering instructor's teaching conceptions and methods.

II. Theoretical Orientation

Because the purpose of this paper is to understand assistant professor's conceptions of teaching, using their own course syllabi and teaching statements to elicit underlying rationales, we selected a more general theoretical framework that will give insight to the potentially conflicting notions of education and teaching that have been documented in literature. We also emphasize that institutional culture—both that of the current institution and the institutions at which a professor was educated—are essential in forming conceptions of teaching, and present difficult barriers to overcome in accommodating new conceptions of teaching. While likely true of most faculty as they enter their professional roles, the participants in this study have all been trained at R1 universities for their graduate work, and then have chosen to pursue non-R1 universities for their faculty careers, for a variety of reasons. As such, we have selected the psychological theory cognitive dissonance, originally proposed by Festinger [18][19], as a lens by which to view the construction and formation of teaching conceptions through experiences that confront previously-held beliefs and attitudes. Theories of cognitive dissonance correspond well with Piaget's theory of knowledge creation—which was originally developed for early-childhood development—humans learn through the accommodation and assimilation of knowledge: Either accommodating new knowledge into an existing schema by rearranging the concepts in the new schema, or assimilating knowledge to fit into an existing knowledge schema [20]. Learning anything new—be it new content knowledge or new experiences—leads a person to "cognitive dissonance" in which a person is forced to either accommodate or assimilate that knowledge. Past literature has primarily applied theories of cognitive dissonance to the education of students [21] and STEM education [22], but also has been applied to teacher education (particularly in the K-12 setting) [23][24][25]. In this study, we seek to extend the theory to study novice professors as they justify their teaching decisions in the engineering classroom.

III. Methods

The participants for this study were 12 non-R1 assistant professors of engineering. Table 1 specifies the participants' numbers, pseudonyms, and the institution type of their current institution. Note there are three participants from four institution types, and one female in each institution category.

Table 1: Participant numbers, names, and institution types

Number	Pseudonym	Current Institution Type
P1	Steven	Baccalaureate
P2	Samantha	Master's
P3	Christopher	Master's
P4	Jason	Master's
P5	Valerie	Baccalaureate
P6	Opie	Baccalaureate
P7	Brandon	R2
P8	Matthew	R3
P9	Molly	R2
P10	Tyler	R2
P11	Richard	R3
P12	Emma	R3

The interview method of document elicitation (based on photo elicitation [17]) using participants' course syllabi and statements of teaching philosophy was implemented. The primary document elicitation interview questions were: "Walk me through one of your course syllabi for a course that you are currently teaching or recently taught," and "Walk me through your current teaching philosophy statement" and were supplemented through semi-structured interview techniques. Data were analyzed using inductive open-and axial coding methods through a constructivist paradigm [26] to achieve the final codebook (Table 2) using the following methods.

A preliminary codebook was developed by each researcher independently by coding three interviews and comparing these open codes. The unit of analysis was typically at the phrase or paragraph level, taking a holistic rhetorical lens to interpret the meaning in relationship with the context surrounding the participant's quote. Then, a finalized version of the codebook was developed from these initial codes through iterative open and axial coding of the data, using NVIVO qualitative data analysis software to capture codes. The two researchers

independently coded each of the transcripts based on this final coding schema, and then met to discuss all the themes, coding to consensus.

Table 2: Final codebook for analysis

Teaching Conceptions (Overarching themes)	**Examples of Corresponding Teaching Methods**
Learning occurs through community	Lecture + something active; team-based activities; individual and team activities; student-led classroom activities
Teaching is to be open, available, and fair	Clarity in objectives and expectations; lecture as an appropriate method; selecting office hours location and times to be optimal for learners; guided inquiry; not requiring an expensive text; appeals process for student disagreement; consideration of how location and room affect pedagogy; discussion-based pedagogy; inclusive practices that help students feel welcome
Teaching is to prepare students for the real world and industry	Teaching ethical responsibility; professionalism and time-management; using analogies; linking content with co-op or real-world experiences; employing authentic experiences; teaching professional communication
Teaching is to motivate students to learn	Place responsibility for learning on the students; providing multiple resources; including a project that is student-led; classroom decisions that direct student attention; motivating students in general
Teaching is to be adaptive	Anticipate and adapt to students' prior knowledge and/or background; Using evidence-based practices; Adaptive policies; Flipped classroom; Share rationale for teaching decisions with students; using technology when appropriate
Assessment is a learning opportunity	Discipline is an opportunity for learning; allow students to question grading; giving reading quizzes; "innovative" assessments; immediate or deliberate feedback
Teaching Philosophies	Expectations vs reality; continuous improvement; inspirational figures (people or resources); inclusivity (including mentorship or making the classroom feel friendlier)
Problematic Notions	Classroom decisions or attitudes that violate one of the other specific themes

The final codebook (Table 2) comprised eight themes, each with several subthemes to capture conceptions of teaching and education. The first six themes are written in the positive valence, noting that many participants justified certain decisions about their courses based on what they believed the positive virtue of teaching to be (for example, teaching is to motivate students to learn, or to prepare students for the real world.)

However, the final two themes, "Teaching Philosophies" and "Problematic Notions" were developed to capture participants' overarching thoughts about teaching and how they formed those thoughts and potentially problematic or worrisome notions about teaching, respectively. For these two themes, we coded both that code, and then the more specific theme to which it closest belonged. As an example, a participant noted that they had policies in their syllabi that they really didn't follow or weren't consistent with: We coded this as "Problematic Notion" and "Teaching is to be open, available, and fair" since that was the conception that was violated in the problematic statement.

IV. Findings

To demonstrate the "whole picture" of our results, we show the frequency of occurrences for each of our themes in Figure 1. The occurrences for each of the themes for each of the participants are captured. The average number of themes for all *except the problematic notions* were averaged to determine the average count per theme for each individual participant. Then, we marked the themes in green that met or exceeded this threshold to show the dominant themes for each participant, as well as the trends more generally. Note that if the number of occurrences of the "Problematic notions" codes met or exceeded this threshold, they are also marked in green indicating a dominant pattern. Any themes that had zero occurrences for a participant, excluding the Problematic notions codes, are marked in light red boxes to highlight aspects of common teaching philosophies that were altogether missing for a given participant. It is noteworthy than there are very few "zero" values, showing that the participants generally have teaching philosophies that span many areas. At the same time, though, three of the participants had "problematic notions" counts in their dominant themes, a topic we engage with in the following results and discussion sections through theories of cognitive dissonance.

We next present excerpts representing each of the themes in the codebook. In particular, we have selected quotations that demonstrate the tensions that exist within each teaching conception. We list the participant number (e.g., P1) behind the pseudonym so readers are able to return Figure 1 to see the "profile" of teaching beliefs.

A. Learning occurs through community:

The "learning occurs through community" teaching conception was described by all but one participant. In many cases, the participants described supplementing their lectures with activities. Very often, these activities involved discussing content with a partner or small group. Sometimes, participants

Theme	Ocurrances by Participant											
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
Assessment is a learning opportunity	3	6	0	2	2	5	1	0	1	3	1	5
Learning occurs through community	8	4	8	6	4	5	0	6	4	6	5	3
Teaching is to be adaptive	2	11	9	2	14	12	6	3	10	2	2	1
Teaching is to be open, available, and fair	10	7	5	3	9	7	4	7	5	4	0	3
Teaching is to motivate students to learn	1	6	11	3	7	9	6	7	6	5	7	7
Teaching is to prepare students for the real world and industry	0	9	3	3	3	5	3	3	5	6	0	9
Teaching philosophy	8	13	2	11	7	5	8	15	23	10	6	3
Average # of Codes	*5*	*8*	*5*	*4*	*7*	*7*	*4*	*6*	*8*	*5*	*3*	*4*
Problematic notions	0	0	0	5	2	0	10	0	7	0	4	0

Figure 1: Occurrences of Themes by Participants

described more extensive team-based practices, including having students lead class activities, such as doing presentations or leading discussions. Research has demonstrated that some instructors are hesitant to use active learning approaches because it introduces uncertainty that can lead to misinterpretation of questions. Steven (P1) addresses this issue as he describes his team-based quizzes:

> "Each module starts off with a quiz […] And then [if the students] thought there was another answer that is valid, there's an appeals process. And I've had students do that a couple of times because they brought up good points, they interpreted something in a way that I didn't expect them to, but that was valid. [….] And I just want students to be clear that we have a way to – not to worry about getting the exact right answer."

Christopher (P3), described the challenge of encouraging valuable student interaction and explaining to students that collaboration is beneficial if done appropriately:

> "The second point is trying to encourage students to have a more collaborative learning experience, but also collaborative in the right way. I want students to talk to each other about homework, I want students to talk to each other about how to do the labs, that sort of thing, because I feel a lot of great learning can happen from peer interaction. But at the same time, I want to make sure that you don't just have any hanger-ons who are essentially copying someone else's work and not getting any of the benefits."

B. Teaching is to be open, available, and fair

The "teaching is to be open, available, and fair" teaching conception was also described by all by one participant. This conception ranged from including very clear expectations and objectives in the course syllabus, to choosing a free textbook, to feeling that it is essential to create an open and inclusive learning environment. Opie (P6) explained why clarity is so important:

> "[A] syllabus is a contract, right? And so I wanted to lay out what the expectations are, both for what they should expect me to do and what I expect them to do, so we are very clear right up front, so then all semester, if something comes up, I can go, look, you're supposed to be doing this, I'm supposed to be doing this. And I generally stick to that, I might not always get a homework back the next class period, but it's within a week for sure, and I always post everything online and they've come to expect that."

Fairness and accessibility to resources, particularly with regard to expensive textbooks, is of current concern to the junior faculty interviewed for this study. For example, Jason (P4) described his decision to use a free textbook because "it's a short reference and it's also totally free online, and that was the main reason, I was trying to lower those costs." This conversation was also linked with conversations around how to create an inclusive environment, the second most common example in this teaching conception. Many faculty members described including a statement on inclusive practices in their course syllabus or statement of teaching philosophy. For example, Valerie (P5) explained that she includes a statement in her syllabus that explained to her students that: "If you're a student in my class, you're going to take an active role in your learning, and you're going to commit to learning and collaborate with peers."

C. Teaching is to prepare students for the real world and industry

The conception about "preparing students for the real world and industry" was described by ten of the twelve participants. Many participants described wanting to present real-world examples to their students, and others described attempting to mimic the real world by asking students to do things professional engineers will do in future jobs. As one example, to connect content with the real world, Tyler (P10) described employing TV examples to teach principles of safety in manufacturing:

> "Yeah, it's this goofy TV show, but they do a bunch of things that are unsafe and they talk about productivity, so there's this one episode where they build an assembly line and it's terribly unsafe, and I used that to introduce how productive and safety are aligned, and basically, as you push productivity more, safety goes down. And if something bad happens in terms of safety, then productivity goes to zero."

In terms of preparing students for the real world, Molly (P9) described teaching students to assess the credibility of their own work:

> "They're just used to solving everything, getting an answer, and saying, 'This is my answer,' But not realizing that […] 'I] can actually do something to check and make sure that my answer is right, before I turn it in,' and trying to get them to understand that because in the real world, you don't have people grading you necessarily. […] You need to be able to do it yourself, as best as you can, so [I give] them the tools that they can do to do that."

Valerie (P5) described feelings of tension about teaching foundational derivations of equations in courses at the expense of real-world applications. She described how she tried to establish the balance in her teaching:

> "So it also kind of comes in to how I feel about derivations. Like, do you teach derivations, or do you not teach derivations […] or how many applications do you teach, which is something that I continuously struggle with. I guess I am more towards the application side, but I know theory is important too. So that's kind of an unanswered question in my life. […] I do feel it is important to show students how what they are learning actually applies in real life, or to the people that actually use it in real life."

D. Teaching is to motivate students to learn

All participants noted conceptions aligning with the belief that "teaching is to motivate students to learn," manifesting in numerous ways. This conception was often connected to why faculty members choose certain assignments and activities in class. For example, many participants described wanting to make the course interesting, exciting, and fun in order to address student motivation. Molly described: "Their interest is in checking off a box, so getting to the point where they can say, they can either be excited about the subject or at least say, 'This is actually kind of fun,' I think is part of my goal." Many participants noted selecting activities to direct students' attention during various assessments class as a way of encouraging growth and learning. Samantha (P2), for example, decided to allow her students to replace one quiz score, rather than dropping one, because:

> "from an assessment standpoint, all ten quizzes covered the objectives, so I didn't want to discount any of them. And I have found, anecdotally at least, that if you let students drop one, they will intentionally tank one. So I didn't want to get into that. I also did give extra credit on some of the quizzes to help make up for an off day, or whatever, to make up from that perspective."

Another mode of motivation was providing multiple resources or materials for students to explore and to accommodate students' individual learning needs and preferences. Opie (P6) noted that they provide more materials than "required" in the class because

> "I'm kind of the mindset that, maybe they don't use everything, but somebody is going to learn better from the group work, somebody is going to learn better form looking at my notes later, someone else is going to learn better from doing a bunch of extra practice problems right before the exam. So I try to make all of those available to people, because I don't know how they learn. I just need to accommodate as best I can. So that's the course materials."

Finally, numerous participants recognized that student motivation is connected to agency and individual interest, thus making sure to have student-directed projects as part of the course, a sentiment echoed by Christopher (P3)

> "I think a lot of the students get the most out of the course when they have an open-ended final project that they can go nuts on… if I give them something like a project, they can be excited about, they'll go out of their ways to push the bounds of what they know."

E. Teaching is to be adaptive

Again, all participants had some form of the theme "teaching is to be adaptive" as part of their teaching conceptions. This conception included describing practices such as making accommodations as necessary, using evidence-based teaching practices such as a flipped classroom or using technology appropriately, and anticipating students' needs and prior knowledge. Richard (P11) described how changing his class structure to a flipped classroom changed the way his students performed, and that by adapting to an evidence-based practice, he was able to better support more students' learning:

> "And then, this time, when I did all the flipping and really changed it up, [the grade distribution] interestingly came out very bimodal. And what I think happened, really, was that this sort of approach helped the students who wanted to do well, but were sort of the bottom end or a little bit weaker. It did not help the people who just really didn't care. […] But it took the sort of middle section and bumped it up a little bit. That's what it felt like to me."

Emma (P12) described some of how she is adapting to her university's students while also making sure she is

> "Developing a classroom that […] is safe enough so that students feel that they are being supported is really important to me. And second, I'm not just telling them what to do […] Some of the awesome feedback I got this semester was '[Participant's name] never tells us the answer and it's the best thing she does for us.' Someone said that. 'Because she makes us figure it out on our own and then we remember it.' That's exactly it, I don't want to tell you the answer because you're not going to remember it, but if you go figure it out, you're going to know."

Finally, Valerie (P5) described how she has included statements in her syllabus to adapt to students' needs, including those that are not visible. She described a part of her syllabus:

> "And then the last bullet on there was actually from our disabilities services person. So, apparently sometimes [students] feel afraid, […] like there might be a rule that I've made that hurts them but I don't know it, but they're like, 'But this is set in stone, so…' – I'm essentially giving them the opportunity to come talk to me, to be like, 'Hey, this grading scheme isn't going to work for me, or I can't turn in homeworks on this day, what can we do?' Or something like that. I haven't actually had that happen."

F. Assessment is a learning opportunity

All but two participants described the "assessment is a learning opportunity" teaching conception, although it was the least frequently coded conception. Participants described various aspects of assessment, and mostly described using assessment

for the purpose of giving students feedback and keeping students accountable for their learning. Additionally, numerous descriptions of innovative assessment approaches were described. Christopher (P3) described how he developed his assessment approach:

> "So, the evaluation. This is something I have been oscillating on, the different things that I have, and that I grade students on, I don't think I found the right balance yet for all of my courses. Historically, I've tried to do problem sets, with tradition midterm, final. The problem with that, is some students will work in groups and get the answers from their peers and then bomb the midterm and final and not really learn anything. So this quarter, I am trying to make the problem sets just completely optional. And then do weekly quizzes to try to keep everyone more individually responsible, and hopefully give them more immediate feedback on their individual abilities. So they can realize, if you don't do these problem sets, if you don't do the reading, if you don't do the studying, it's going to hurt you sooner rather than later."

As for innovative assessments, Matthew (P8) described how and why he decided not to have a final exam, leveraging the unique project-based features of his course, in which his students prepared authentic museum exhibits:

> "The audience of the [Science Museum] is mostly second through sixth graders […] Other people also come but mostly it's elementary school field trips that go there. And so I was thinking, you know, if my students can explain conductivity to a second grader, they shouldn't have to take a final exam."

G. Teaching Philosophies

As part of the document elicitation protocol, participants were asked to describe their teaching statements, thereby eliciting descriptions of teaching philosophies. As such, all participants noted at least a few, as they described general beliefs about teaching and what kind of classroom environment they believe in, as well as various forms of inspiration that affected the participants' beliefs about teaching. Participants also described tensions between their expectations and the reality of teaching, showing where cognitive dissonance often arises in teaching.

Steven (P1) described how part of his teaching philosophy is to connect course content with a subject's history and background. However, he also describes how the reality and constraints of teaching do not allow him to fully enact this belief:

> "I would say that my philosophy still [is the same], but the mechanics of that look a lot different now. And one of the reasons is that I had trouble keeping that model up for an entire class. You can do ten or fifteen minutes on it, or you can do one class out of a unit on it, but […] the pace wasn't predictable enough. You had a pretty big curriculum to get through, especially in engineering, and we just can't spend an entire class asking ourselves what experiments were done by the early thermodynamics pioneers, we have to get on to what do we take away from that and how do we apply it to modern day problems? I think the team-based learning has helped with that. Because they get the background."

Most participants shared a spirit of continuous improvement. For example, Richard (P11) described his personal tension in improving teaching given time limits:

> "I'm kind of pragmatic about it, I'll be honest with you. I'm not – teaching is only supposed to be 30 to 40 percent of my workload, at this moment, at this time. I'm a person, just my general personality is that I'm always trying to improve in everything that I do, so I'm certainly wanting to improve my teaching, but I would not say, honestly, that I've been taking these hugely drastic steps. It's mostly been incremental. Like, how much better can I make it for how much time I actually have?"

In terms of how the participants described their teaching philosophy statements, many described how they were inspired about their teaching, either as a result of role models, anti-role models, or resources or experiences they had leveraged. For example, Molly (P9) explained:

> "And then [PhD University…] made an effort to promote teaching and improve teaching among the faculty, and so one of the ways they did it was they'd bring in a guest speaker who was a well-known teacher in chemical engineering to give a seminar - two seminars, actually. One on their research area and one on their teaching area, and so some of this I gained from hearing those talks. […] I usually would try to go to those just to get some ideas on what makes a good teacher in engineering."

Richard noted that while they saw their father, "who was an awesome teacher" as a role model, in their own engineering experience "I haven't had that one awesome teacher. Not in college […] But I can think of some that were just –I'm *not* going to do that! […]" noting the importance of anti-role models in determining who they were going to be as a future professor.

H. Problematic Notions

The code "problematic notions" was not one of the teaching conceptions we were originally looking for but emerged from the data when we recognized conceptions of teaching that are at odds with evidence-based practices and the generally positive nature of the other themes manifesting in our data. Of the twelve participants, five participants had descriptions that we coded as problematic notions, some with more occurrences than others (see Figure 1). Some of these notions included descriptions such as: not needing to use evidence-based practices with graduate students; not being strict with an written syllabus policy (e.g., attendance); not including a course schedule; using subjective accounts of attendance to bump up students grades at the end of the term; and only including evidence-based practices in a teaching statement in order to "get the job."

One particular interesting code to note is on "open, available, and fair" or "inclusive practices" that in a nuanced way can

quickly transition to being a concerning practice. For example, numerous participants described course policies that they included on their syllabus but then did not enforce in practice. While we understand that there are sometimes exceptional circumstances for students, and that to be inclusive they should be treated equitably, we saw a few examples in the interviews in which this turned into inconsistent application of policies. In one instance, one participant described his practice of usually making accommodations for students who emailed him requesting being able to submit late work. In another case, a participant noted building in "discretion" to the grading schema: "If I feel somebody needs a higher grade than what their exams predicted, I have the liberty to do that under the syllabus."

In cases like this, especially with students emailing after the deadline and still having their work graded for full credit, we are concerned about equity. In this case, vocal students are rewarded for being the "squeaky wheels" while other students quietly accept the consequences for missing the deadline, not knowing that other students are getting special treatment if they ask. The point we want to make here is that adaptive teaching practices can be inclusive when applied fairly but can also be exclusive, and it's important to be aware of the possible ways making exceptions to policy might be considered unfair for the rest of the class. While some of the participants noted the importance of consistency and fairness in these respects, other participants did not connote to us that they understood any problematic nature to these thoughts.

Another problematic notion that manifested both in good and problematic ways happened when instances of participants describing their need to manage their time associated with teaching given other parts of a faculty member's job. However, we wanted to highlight two examples that demonstrate different approaches to considering time constraints. The first is a positive approach to time management from Matthew (P8):

> "…officially, I am supposed to spend 10% of my time on teaching. […] So that's four hours a week of time spent teaching, out of a 40-hour week. And the class meets for two-and-a-half hours, so that gives me 90 minutes a week to prepare things and grade, and I try to adhere to that. And so each week, I read the chapters that I have assigned to my students, take about six pages of notes for myself before class starts. I make a summary sheet for the – what I've distilled down – I use my six pages of lecture notes to lecture on and then I also make about six to ten worksheet questions, so the students get the worksheet and the summary sheet. And then at the beginning of class, I give a little intro, a little clicker quiz to check that everybody's read everything, to keep students reading throughout the semester. And then I'll typically start lecturing for about 10 or 15 minutes before I have students dive in and get started on questions. And if students get stuck, I kind of feed information back until we have worked through the worksheet. And it's been effective both from an opportunity to wrestle with the content and from a management of my time perspective. It's a fun engineering problem – how do you teach a class if you have four hours a week and you meet for two-and-a-half of those. Here's my solution!"

Matthew showed evidence of using many evidence-based best practices—guiding student attention during class, using formative assessments like clickers, and incorporating discussion-based pedagogies as students complete their questions sheets during class with their classmates. In this sense, this participant is maximizing their teaching effectiveness within a limited amount of time.

In contrast to Matthew, Richard (P11) discussed how they engage students and prepare to teach within finite time constraints, but with several problematic nuances:

> "[The] first thing I do is I come in and count to see what my attendance looks like. I'm not taking attendance […] I am sometimes looking to see if specific people are here or not, but I keep no record of it. […] I want to have a, at least a general idea of, of how many people are attending and how consistent the same people it is because that feeds back into my grading, and how I help students who are struggling. Then I usually ask a series of diagnostic questions about the previous lecture's material. And I get up in their faces and I call on people who might not answer sometimes. If somebody can't answer the question, I'll let it hold, you know, for a while and I say, okay, somebody help them out. So I don't let people off the hook […] I do a traditional lecture. I write on the whiteboard, I talk about concepts, I do very few videos and multimedia…I'm not showing a live Twitter stream in class. The reason here is not because those things are bad, but the classes which I teach aren't helped a whole lot by that kind of stuff. And if they are, they take a whole lot of time to produce."

When directly asked about this person's teaching statement, which centered around active learning principles, that same participant noted,

> "I was trying to get the job, right? I think I can do [active learning] in the classroom, and when I do […] I'm not doing a flipped classroom, I'm not doing any of these kinds of, 'Well, I don't really teach, you teach me.' No, I'm teaching them. But it's by getting in their face and forcing them to answer questions and not giving them the answer right way. No, I'm under time constraints, I can't let them sit and think about it for half an hour like I would like to."

Here, we see the differences between the first instructor who excels within the time constraints for teaching to still implement evidence-based best practices and active learning, in direct contrast with a professor who demerits the value of "active" pedagogies and conflates them with a seemingly confrontational approach to teaching justified by "the time constraints" as evidence of our "problematic notions" code.

V. Discussion

From the findings, we can see that the method of document elicitation using course syllabi and statements of teaching

philosophy revealed detailed descriptions of the participants' teaching conceptions and practices. When considering these findings in light of the theoretical orientation of cognitive dissonance, we see that teaching and the decisions instructors need to make in relation to their teaching practices are constantly facing the need to accommodate and assimilate their knowledge about teaching within some constraints imposed by time and/or their campus culture. While past literature has noted how teaching philosophies are often in tension with indicators of merit for tenure and promotion [27][28][29], fewer studies characterize what conceptions engineering professors have and where they come from. Studying a population of junior faculty members, therefore, is an interesting contribution to this literature. Many of the participants noted the origins of their teaching philosophies with respect to either professors or mentors they admired, and some noted being inspired by 'anti-mentors' or people they vowed never to become like. This finding points to the role that mentorship and role modeling plays in the formation of the future professoriate—for better or worse [30], and the importance of exposure to events, experiences, or resources to inform innovative teaching practices, as has been noted by other scholars [31][32][33].

Many of our participants noted they faced elements of cognitive dissonance during the transition into the pressures and constraints of a faculty job. Many described how their courses were not as perfect as they could be, or may not perfectly align with their idealistic teaching statements, but are always improving in a spirit of continuous growth and improvement, calling to mind Dweck's work on growth mindset [34], which has been applied to student learning in computer science and engineering education [35][36] but not to faculty. When faced with this opportunity for cognitive dissonance, these participants prioritized their most closely held teaching philosophies, while also understanding that it could take infinite time to teach a "perfect" course. The reconciling of these cognitive dissonances, though, were still based in healthy educational practices, many of which are (either intentionally or unintentionally) evidence-based and align with literature.

It was also clear that some of our participants are not aware of or have not been confronted with the inconsistencies and problematic notions that they hold as teaching philosophies, which manifested in the Problematic Notions theme, a facet of teaching conceptions that has not been well-explored in literature. We used this theme when a participant described a belief or practice that was at odds with evidence-based teaching practices. Often these problematic notions did not seem realized to the participants as being problematic, while in other cases, the participants realized that their practice did not feel correct. One common example of unrecognized dissonance happened in conversations related to equity and inclusion, using the words to describe commitment to these values, but in practice altering little about the pedagogical environment. Our findings show specific examples of how and why these misalignments continue to happen, illuminating potential areas of disconnect. Another common unrecognized dissonance (or one that the participants didn't seem to care about) is consistent application of syllabus policies (e.g., with respect to attendance, enforcing late grading policies, etc.). These day-to-day classroom management issues are likely due to lack of pedagogical training [37], but also are problematic from the point of view of transparency, fairness, equity, and inclusion.

Further, several other problematic notions arose related to the inherent constraints on a professor's time. While some participants tried to thrive and do the best for their students even given restrictive constraints (calling to mind Matthew's strategies for time management) are in stark contrast to Richard's approach to the same issue, which is to use time constraints as an excuse for not reforming teaching practices, blatantly admitting he used pedagogical words in his application materials (e.g., "active learning") to—in his words—"get the job."

VI. Applications and Conclusions

While this study was not an intervention study, appropriately designed activities employing examples of cognitive dissonance have been useful in changing attitudes. For example, McFalls and Cobb-Roberts [23] employed cognitive dissonance theory in interventions associated with equity and diversity training. In combination with our findings that many of our participants had encountered instances of or experiences of poor teaching in which they actively decided to pursue another route of teaching, the opportunity for cognitive dissonance-based pedagogical interventions may be an interesting avenue for future work for researchers, for centers of teaching and learning, or to evaluate teaching for promotion and tenure in a different mode than traditional student-informed end-of-term evaluations [10] (which have been shown to be biased [38]) or peer teaching evaluations, which may promote and replicate poor teaching. We also note potential for the use of document elicitation as a method during the faculty interview process as a way to probe faculty candidates' rationales for their teaching methods and philosophies. While candidates would surely not respond that they wrote it to "get the job" (as our problematic participant noted,) it could be telling to be able to probe candidates' rationales for various buzzwords like "active learning."

In summary, we used a document elicitation in which participants were asked to explain the background and decisions behind a course syllabus they created and their statement of teaching philosophy. The research question we were aiming to answer was: In what ways do assistant professors of engineering conceptualize their roles and decisions toward teaching decisions? We found a total of eight themes that describe common manifestations of teaching conceptions showing how junior engineering faculty envision their roles as educators. We also captured the origins of these philosophies and uncovered several "Problematic Notions" that have not, before this, been described in literature. Based on the richness of the data collected from the method of document elicitation applied to teaching philosophies, we envision that the approach could be successful in faculty interviews or teaching evaluations.

ACKNOWLEDGMENTS

We thank the participants from this research study, and the reviewers that offered their constructive feedback to this work.

REFERENCES

[1] Association of American Universities. (2017). Progress Toward Achieving Systemic Change: A Five-Year Status Report on the AAU Undergraduate STEM Education Initiative. Washington, DC.

[2] National Academies of Sciences, Engineering, and Medicine 2016. Quality in the Undergraduate Experience: What Is It? How Is It Measured? Who Decides? Summary of a Workshop. Washington, DC: The National Academies Press. https://doi.org/10.17226/23514.

[3] Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, *111*(23), 8410-8415.

[4] Matusovich, H. M., Paretti, M. C., McNair, L. D., & Hixson, C. (2014). Faculty motivation: A gateway to transforming engineering education. *Journal of Engineering Education*, *103*(2), 302-330.

[5] Felder, Richard M., and Rebecca Brent. *Teaching and learning STEM: A practical guide*. John Wiley & Sons, 2016.

[6] Ropers-Huilman, B., Carwile, L., & Lima, M. (2005). Service-learning in engineering: A valuable pedagogy for meeting learning objectives. *European Journal of Engineering Education*, *30*(2), 155-165.

[7] Mills, J. E., & Treagust, D. F. (2003). Engineering education—Is problem-based or project-based learning the answer. *Australasian journal of engineering education*, *3*(2), 2-16.

[8] Smith, K. A., Douglas, T. C., & Cox, M. F. (2009). Supportive teaching and learning strategies in STEM education. *New Directions for Teaching and Learning*, *2009*(117), 19-32.

[9] Chiu, P. H. P., & Cheng, S. H. (2017). Effects of active learning classrooms on student learning: a two-year empirical investigation on student perceptions and academic performance. *Higher Education Research & Development, 36*(2), 269-279.

[10] Subbaye, R., & Vithal, R. (2017). Teaching criteria that matter in university academic promotions. *Assessment & Evaluation in Higher Education, 42*(1), 37-60.

[11] Smith, M. K., Wenderoth, M. P., & Tyler, M. (2013). The teaching demonstration: what faculty expect and how to prepare for this aspect of the job interview. *CBE—Life Sciences Education, 12*(1), 12-18.

[12] Patrick, L. E., Howel, L. A., & Wischusen, W. (2016). Perceptions of active learning between faculty and undergraduates: Differing views among departments. *Journal of STEM Education: Innovations and Research*, *17*(3).

[13] Tharayil, S., Borrego, M., Prince, M., Nguyen, K. A., Shekhar, P., Finelli, C. J., & Waters, C. (2018). Strategies to mitigate student resistance to active learning. *International Journal of STEM Education*, *5*(1), 7.

[14] Light, G., & Calkins, S. (2008). The experience of faculty development: Patterns of variation in conceptions of teaching. *International Journal for Academic Development, 13*(1), 27-40.

[15] Borgford-Parnell, J. L. (2015). A Pedagogy of Larger Concerns: Grounding Engineering Faculty Development in Research on Teaching Conceptions. *Paper presented at 2015 ASEE Annual Conference & Exposition.* Seattle, Washington. 10.18260/p.23421

[16] McKenna, A. F., & Yalvac, B. (2007). Characterizing engineering faculty's teaching approaches. *Teaching in Higher Education*, *12*(3), 405-418.

[17] Harper, D. 2002. Talking about pictures: A case for photo elicitation. *Visual Studies, 17*(1), 13-26.

[18] Festinger, L. (1962). *A theory of cognitive dissonance* (Vol. 2). Stanford university press.

[19] Harmon-Jones, E., & Mills, J. (2019). An introduction to cognitive dissonance theory and an overview of current perspectives on the theory.

[20] Piaget, J. (1972). Development and learning. *Readings on the development of children*, 25-33.

[21] Misiti Jr, F. L., & Shrigley, R. L. (1994). The Role of Cognitive Dissonance on the Science Attitudes of Middle School Students.

[22] Aïmeur, E. (1998). Application and assessment of cognitive-dissonance theory in the learning process. *Journal of Universal Computer Science*, *4*(3), 216-247.

[23] McFalls, E. L., & Cobb-Roberts, D. (2001). Reducing resistance to diversity through cognitive dissonance instruction: Implications for teacher education. *Journal of teacher education*, *52*(2), 164-172.

[24] Chiou, W. B. (2006). Using cognitive dissonance to enhance faculty members' attitudes toward teaching online courses. *Psychological reports*, *99*(2), 465-471.

[25] Pedder, D., & Opfer, V. D. (2013). Professional learning orientations: patterns of dissonance and alignment between teachers' values and practices. *Research Papers in Education*, *28*(5), 539-570.

[26] Charmaz, Kathy. (2006). *Constructing grounded theory: A practical guide through qualitative analysis*. Sage.

[27] Shapiro, H. N. (2006). Promotion & tenure & the scholarship of teaching & learning. *Change: The Magazine of Higher Learning*, *38*(2), 38-43.

[28] Roesset, J. M., & Yao, J. T. (2002). Engineering faculty reward systems. *Journal of Professional Issues in Engineering Education and Practice*, *128*(3), 95-98.

[29] Wankat, P., & Oreovicz, F. (2003). Tenure and teaching. *Journal of Professional Issues in Engineering Education and Practice*, *129*(1), 2-5.

[30] Oleson, A., & Hora, M. T. (2014). Teaching the way they were taught? Revisiting the sources of teaching knowledge and the role of prior experience in shaping faculty teaching practices. *Higher education*, *68*(1), 29-45.

[31] Austin, A. E. (2002). Preparing the next generation of faculty: Graduate school as socialization to the academic career. *The journal of higher education, 73*(1), 94-122.

[32] Austin, A. E. (2003). Creating a bridge to the future: Preparing new faculty to face changing expectations in a shifting context. *The Review of Higher Education, 26*(2), 119-144.

[33] Austin, A. E., Sorcinelli, M. D., & McDaniels, M. (2007). *Understanding new faculty background, aspirations, challenges, and growth. In The scholarship of teaching and learning in higher education: An evidence-based perspective* (pp. 39-89). Springer, Dordrecht.

[34] Dweck, C. S. (2008). *Mindset: The new psychology of success*. Random House Digital, Inc.

[35] Lucas, B., & Hanson, J. (2016). Thinking like an engineer: Using engineering habits of mind and signature pedagogies to redesign engineering education. *International Journal of Engineering Pedagogy*, *6*(2), 4-13.

[36] Murphy, L., & Thomas, L. (2008, June). Dangers of a fixed mindset: implications of self-theories research for computer science education. In *Proceedings of the 13th annual conference on Innovation and technology in computer science education* (pp. 271-275).

[37] Brent, R., & Felder, R. M. (2003). A model for engineering faculty development. *International Journal of Engineering Education, 19*(2), 234-240.

[38] Mitchell, K. M., & Martin, J. (2018). Gender bias in student evaluations. PS: Political Science & Politics, 51(3), 648-652.