

AC 2008-1199: WE ALL TAKE LEARNERS INTO ACCOUNT IN OUR TEACHING DECISIONS: WAIT, DO WE?

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We all take learners into account in our teaching decisions: wait, do we?

Abstract

Creating a learner-centered environment within an instructional setting is a goal which engineering faculty are encouraged to achieve. However, little has been studied of how engineering educators actually incorporate learner issues into their teaching. In this paper we report on this issue by describing how three engineering educators talked about learners in the context of talking about teaching decisions. In particular we characterize the range of dimensions mentioned by the educators, the source of their information, and the way they used the information. We focus on learner characterizations in three specific areas related to: interacting with students, student ratings and in the context of active learning. We situate this work in notions of theories of learner-centeredness and the current body of scholarship providing characterizations of engineering students and their learning. The findings remind us of the complexity of on-the-ground teaching activity.

Introduction

Literature on engineering education and teaching in general suggests that educators should focus on the learner^{1,2,3}. Despite the relevance of this issue, little has been published to date about how engineering educators actually incorporate learner issues in their teaching, and it is simply unclear how learners actually figure into things in teaching practice in engineering. Further, there is reason to wonder the extent and ways in which practicing educators take learners into account. Factors that might affect the extent to which engineering educators can and do take learners into account include the minimal amount of formal training most engineering educators receive for teaching, the notion that learners are only one of the many things educators have to take into account in teaching, and the observation that teaching is only one of an engineering educator's/faculty member's responsibilities.

In this paper, we address this issue of how engineering educators take learners into account in their teaching through case studies of three engineering educators. These case studies are theoretically sampled from a larger dataset of engineering educators asked to provide descriptions of teaching decisions. Because the educators were asked to report on teaching decisions broadly and not specifically asked about students or learners, we have had the chance to see how the educators naturally brought learner issues into the teaching. In our analysis, we explored how the engineering educators talked about and characterized their learners; the ways in which the learner characterizations were linked to their teaching decisions; and the source of their information about learners.

The major findings from our case study analysis included how the three educators characterized teacher/student relationships, the ways in which they interacted with students, their views on using student ratings, reasons for using active learning as a specific pedagogical approach, and their sources of information. While all three educators characterized teacher/student relationships as starting with mutual respect, they used two very different analogies to describe teacher/student relationships: the parent/child analogy, and the senior colleague/junior colleague analogy. All three developed their own models for interacting with students in large groups and felt students

needed to have access to individualized help, however they differed in the specifics of how to offer opportunities for access. They also had differing views about how to use student ratings and evaluations although all acknowledged that student ratings and evaluations were a way for students' voices to be heard and validated. Similarly, they all talked extensively about using active learning approaches in their classrooms but each educator had their own individual reasons for employing active learning in the classroom. The source of their information about students seemed to be derived primarily from their personal experiences of interacting with students and observing student behavior. Occasionally these educators used their own experience as a learner as a stand-in for students or a point of guidance when making decisions. To a lesser extent they reported obtaining information about students through discussions with colleagues. The sources of information mentioned least were campus teaching resources (e.g., teaching workshops and faculty developers) and educational literature.

Background

A concern with how engineering educators can and should take learners into account in their teaching is growing increasingly salient because of the mismatch in scope between the growing body of information available about engineering students and the extent to which the educators' should be using such information. Asking educators to report on teaching decisions represents a way to explore how these issues map to teaching practice.

Visions of students

In the past two decades, the engineering education research community has begun to accumulate a significant body of information that characterizes the students who engage in engineering programs and their approaches to learning engineering content and skills. Some themes in this growing body of literature include a documentation of students' conceptions and misconceptions in specific content areas, an emphasis on additional dimensions of engineering knowing such as intellectual development and identity development, an emphasis on factors that support learning such as self-efficacy, and an emphasis on incoming characteristics of students. Often these studies include data comparing students across campuses, over time, and with practitioners.

Articles in the recent special issue of the Journal of Engineering Education serve to showcase this growing body of scholarship⁴. Information about engineering students and engineering learner had a strong representation in the special issue. Since this issue was meant to showcase the journal as a research venue, trends in the content of the paper can be interpreted as trends in the scholarship more broadly. For example, the paper "Research on Engineering Student Knowing: Trends and Opportunities" presented a view of 13 studies of student knowledge including examples of research on students' conceptual frameworks and misconceptions, their attitudes about engineering and about their own skills, their approaches to engineering design at different stages of the curriculum, and the development of their conceptual understanding and problem-solving skills in specific engineering disciplines⁵. The paper by Felder and Brent, also a review of other research, focused on characterizing students in terms of their learning styles, their approaches to learning (deep, surface, and strategic), and their levels of intellectual development⁶. The paper by Dym and his colleagues ("Engineering Design Thinking, Teaching, and Learning") provided a great deal of insight into what students know and can do in terms of design⁷.

The existence and mission of the Academic Pathways Study (APS) is also evidence of the commitment of the engineering community to understanding engineering learners and their learning processes. This study is a multi-million dollar effort to provide a multi-faceted characterization of engineering students over time, across institutions, and through multiple methods⁸. The twelve APS-related papers published at the 2007 American Society of Engineering Education conference provide a good representation of the study. These papers address issues related to persistence and “doggedness”^{9,10,11}, the admissions process¹², engineering design behavior^{13,14,15}, student perceptions of their education and their career aspirations¹⁶, identity¹⁷, sponsorship¹⁸, conceptions of engineering¹⁹, and the perspectives of international students²⁰.

Still further, the notion of scholarship devoted to characterizing learners and their learning was codified during the recent agenda-setting colloquies as one of the five areas of scholarship important to engineering education²¹. Below is the description of this area of research as envisioned by the colloquy participants, with descriptions of the research questions starting in line 9 of the quote below:

“Area 2—Engineering Learning Mechanisms: Research on engineering learners’ developing knowledge and competencies in context. Experienced engineers and scientists from around the world are accelerating the pace of discovery and transformation of this new knowledge into viable products, processes and services. However, maintaining this growth potential coupled with the retirement of expertise from technical disciplines will require a transformational change in how we prepare our learners across all ages. Therefore, fundamental research that describes the knowledge, skills, and attitudes learners’ bring to their engineering education that influences what they learn as well as how students develop the ability to learn, think, innovate, and problem solve like an engineer will challenge current assumptions about how we teach and assess for understanding. Learning to engineer will require three major strands of inquiry that centers on understanding: 1) learners acquisition, comprehension, and synthesis of domain specific knowledge to achieve contextual goals; 2) the learning progressions of learners and their educational experiences that develop this knowledge and identity necessary to be an engineer; and 3) the variance of knowledge, skills, and attitudes of a diverse population of learners.” (p. 260).

Indeed, the body of information we are generating about engineering students and their learning is impressive (and we have only tapped the surface in the above sketch of this research) and can be expected to grow. Moreover, the body of information gets even larger when we start to incorporate studies that are not limited to but include engineering students (e.g., Seymour and Hewitt²², Beyer, Gillmore, and Fisher²³, Nathan²⁴).

But, what exactly was the motivation for generating so much information? What is the vision of how such information can and should guide educational practice? In the next section we turn to the underlying reasons for why the community is generating such a large body of information, with particular attention to what we expect educators (or others) to do with the information. This

information, in turn, forms the backdrop for an exploration into the types of information educators are currently using and how they are using it.

Visions of what teachers should do with student information

Clearly, many things contribute to effective teaching. One modern core philosophical (and empirically validated) belief is that effective teaching involves taking learners and learning into account. In much of the literature on teaching, this type of belief is characterized as “being learner-centered.” As we discuss below, what is exactly meant by “being learner-centered” is not clear.

The phrase “learner-centered” appears explicitly in at least three different contexts. In the seminal book, *How People Learn*, the authors suggest that “learner-centered” is an important feature of an effective learning environment. They further explain that environments which are learner-centered, “pay careful attention to the knowledge, skills, attitudes, and beliefs that learners bring to the educational setting” (p. 121). In their framing, learner-centered is only one of four features of an effective environment. A second use of the phrase learner-centered appears in the design philosophy published by Soloway, Guzdial, and Hay. Here, the authors suggest that software that effectively supports learning will be learner-centered, which they further operationalize as taking into account three key features of learners: growth, motivation, and diversity. A final instance of the phrase learner-centered appears in the work of Kember, and some of the researchers that he cites in his review of the literature on teaching conceptions. In this context, Kember is reporting on research investigating the conceptions of teaching held by effective teachers across a range of studies into teaching conceptions. His conclusion is that across the studies, a trend toward learner-centered conceptions emerges (as opposed to teacher-centered). In this work, a learner-centered conception of teaching involves a composite of the way a teacher frames the task of teaching, the relationship being the learner and the teacher, the instructional choices that are chosen, and the learner information taken into account.

Visions of what it might mean to be learner-centered can also be found elsewhere. For example, educators wanting to support conceptual change are often encouraged to help students confront their prior conceptions in order to move towards more widely accepted conceptions²⁵. This implies that the educator has knowledge about the learners’ prior conceptions, and assumes that if students start with a wide range of conceptions, then the educator would presumably have insight into that wide range of conceptions. On a different note, if the field of educational psychology represents the information from psychology more broadly than is relevant to education, then the implication is that the content of such textbooks represents information educators can use. As such, the table of contents of such textbooks (including chapters on issues such as motivation, problem-solving, cognition and learning, individual differences, gender development, exceptionality, and gender development) represents yet another image of what it means to be learner-centered (i.e., a learner-centered instructor would be one who takes these types of issues into account). Learner-centeredness may also be implicit in other areas even when not articulated as such. Consider Shulman’s notion of pedagogical content knowledge, which he defines as follows: “Within the category of pedagogical content knowledge I include, for the most regularly taught topics in one’s subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations — in a word, the ways of representing and formulating the subject that make it

comprehensible to others.” (p. 203)²⁶. While this definition does not explicitly invoke the notion of effective for particular learners, it is easy to imagine that pedagogical content knowledge might have a learner-dimension to it (e.g., this analogy is good for this type of learner, this example is good for that type of learner).

This review suggests that the notion of being learner-centered is multi-faceted—that the visions are complimentary but not identical. The explicitly articulated visions of being-learner centered are broad, suggesting the wealth of information that could be involved in being learner-centered. It is also clear that all of the visions extend beyond a simple “did they take learners into account or not” view. The difficult-to-align nature of the visions does raise questions such as whether certain types of information are more important than other types, how the information should be effectively organized to support teaching practice, and what would count as an effective use of information about learners. The review also raises questions about how these various ways of taking learners into account map to the extent and the ways in which practicing engineering educators currently take learners into account, questions that we address in this paper.

Research questions

This paper addresses the following questions: a) To what extent are engineering educators currently taking into account learners in their teaching? b) How do engineering educators characterize their learners when they do take them into account (what information, how is the information organized)? and c) Where do engineering educators get their information about their learners? In the next section, we introduce the idea of teacher decision-making as a context for exploring these questions.

Decisions as a means of looking into these issues

Teaching decisions represent a context for the use of information such as student diversity, student prior knowledge and misconceptions, learning styles, and the variety of different teaching strategies. Teaching decisions are windows into teaching practice in that decisions represent commitments to action—the actions of teaching. Thus, having educators reveal information about teaching decisions provides opportunities to learn about how they take learners into account in their teaching practice.

There are many challenges to understanding decision-making because it is a subjective activity, making it difficult to research and study directly. While most engineering educators acknowledge that they make some explicit decisions, most of their decisions are invisible and unspoken. As researchers, we cannot “see” or “witness” a decision, and therefore must infer from observable behavior or participants’ self-reported comments that a decision has been made. The study of the decision-making process is also made more difficult by the ephemeral nature of decisions which happen quickly in people’s minds. The challenges related to conducting research about making decisions may have contributed to the paucity of studies that examine teacher thinking and teacher decision-making in higher education.

Although little has been published regarding teaching decisions within the context of science, technology, engineering and mathematics (STEM) education, some qualitative studies about teacher decisions in higher education do exist. In the United Kingdom, Young and Irving interviewed 46 faculty who taught social policy to undergraduates about their teaching

approaches and methods²⁷. They found that while the majority of the faculty participating in the study spent a significant amount of time thinking about teaching and preparing to teach, they relied primarily on “tacit knowledge based on their experiences as students and couched in terms used by colleagues.” They made little use of specialized or technical language in discussing their teaching and teaching decisions which had implications for their “ability to make explicit and justify decisions relating to professional practice”, which Young and Irving described as “integrity of practice.”

The bottom line is that exploring educator decision-making represents a promising approach way to address the research questions driving the paper assuming we can find an appropriate methodology. The next section describes our use of the Critical Decision Method approach to gain information about teaching decisions and subsequently explore the role of learner information in those decision processes.

Methods

In this section we first present the theoretical basis for the interview protocol and the process we used to analyze the interview data that we collected. We will then describe the demographics of the engineering faculty who participated in this study. Finally, we address the analysis approach we used to address the questions of interest.

Interview Protocol

Our study used the Critical Decision Method (CDM)²⁸ approach to gain insight into teaching decisions made by engineering educators. Klein describes the CDM protocol as:

“The CDM, like all critical incident techniques, focuses on non routine cases. Incidents that are non routine or difficult are usually the richest source of data about the capabilities of highly skilled personnel . . . In a critical decision interview, questions always refer to a specifically recalled incident. We usually obtain more specific and useful information when we probe concrete and non-routine events than when we ask about general rules and procedures . . . probing in the CDM is not limited to responses that can be objectively anchored and verified. Questions can sometimes require the decision makers to reflect on their own strategies and bases for decisions . . . the probes are designed to obtain information at its most specific and meaningful level . . . thus we ask the decision-maker to select an incident that was challenging and that, in his or her decision-making, might have differed from someone with less experience.” (p. 465-466)

In our case, we asked faculty to describe two specific teaching decisions that they had made recently: (1) a decision that they made during the planning stage of a class, and (2) an interactive decision that they made “on the fly” during an interaction with students. In addition, we asked the educators to provide background information about themselves, to define a teaching decision in their own words, and to summarize their process for making decisions about their teaching in general. In order to be consistent with the CDM method, we asked educators to choose decisions that were memorable, recent, and interesting to them. We found that for many of the educators, the memorable and interesting decisions that they chose to discuss during the interview were memorable and interesting to them because they were non routine or challenging.

Participants

Overall, we interviewed 33 engineering faculty at a major research oriented university. The interviews ranged from 45 to 90 minutes, and each interview was recorded and later transcribed. All names used in this paper are pseudonyms in order to protect the confidentiality of the participants. The faculty participants came from nine of ten engineering departments. Of the faculty interviewed, 12 were full professors with tenure, 7 were associate professors with tenure, 7 were assistant professors on a tenure track, and 7 were non-tenure track faculty. Four of the participants had high-level administrative roles within the university in addition to their faculty appointments. We deliberately oversampled for women in the study, with 23 male and 10 female faculty participating, or 30.3% female faculty in our sample.

Analysis – Case Studies

In this paper, we focus on 3 participants in order to provide a rich initial answer to the research questions. These participants were chosen to be representative of the larger data set: the participants represent 3 different engineering departments, both genders (2 men, 1 woman), and different academic ranks (2 full professors, 1 associate professor). All three educators were experienced teachers (between 10 and 40 years of teaching experience at time of interview) and had various levels of experience with non-academic professional contexts such as industry, government, or non-profits.

Our analysis involved a detailed reading of the three transcripts, coding any instance in each transcript in which learners, or students, were acknowledged or mentioned. The interview protocol did not ask the educators to talk explicitly about the learners or how they took learners into account. Rather, we asked participants to elaborate, discuss, and list the factors they took into account when making decisions about their teaching. Not surprisingly, students were evident throughout their interviews. Therefore, we were not coding their responses to any specific question but rather their responses as they related to learners/students in the context of their narratives.

For the three case studies, we looked at the portions of their narratives in which they mentioned anything to do with learners for evidence of (a) how they talked about learners generally, (b) how they characterized learners, (c) how they used information about learners, and (d) what was the source of their information about learners. The semi-structured interview protocol did not include specific prompts for learners, or students, but rather asked participants to describe all of the factors they took into consideration when making a specific decision. All participants talked about students as a factor they considered. When participants alluded to their sources for information about students we asked them further questions about their sources and included these responses in the analysis. We now provide some context and background about the three participants chosen for this case study analysis:

- **Ted:** Ted is an engineering educator who has an interdisciplinary background and more than 20+ years of teaching experience within a non-traditional engineering department. He has been deeply interested in engineering education issues for many of those years. Because of that interest, he stated directly that he might be different from “traditional” engineering faculty. He reported having little professional experience outside of academia; however he indicated that he was very involved with national and local professional engineering

communities. He self-reported being disappointed with his student ratings, saying “I didn't get stellar ratings.” Perhaps because of this and his interest in education, Ted reported attending a lot of workshops about teaching and learning, and working with faculty developers.

- **Nathan:** Although not trained as an engineer, Nathan is an engineering educator with an interdisciplinary background and more than 10+ years of teaching experience within a traditional engineering department. He reported having significant professional experience outside of academia through consulting. At the time of the interview, he was engaged extensively in research collaborations with government and non-profit organizations. He claimed to be very interested and vested in his teaching career and teaching-related issues. Overall, he seemed reasonably satisfied with his student ratings, reporting them as good to excellent. However, he felt the need to improve his ratings and did so by continuing to modify the courses that he teaches, and to seek out resources when developing new courses.
- **Fay:** Fay is an engineering educator who was trained in a traditional engineering discipline and has 15+ years of teaching experience within a traditional engineering department. She reported having limited industry experience, which consisted mostly of internships while she was a student. In her position at the time of the interview, she has collaborative relationships with industry, government, and non-profit organizations. She was very satisfied with her student ratings, self-reporting that they were excellent. She said that student ratings were important to her and said she often worked with faculty developers to do mid-term student evaluations in her classes.

Over the course of the analysis, we observed that all three educators spent time characterizing learners across many dimensions. Thus, we subsequently analyzed the information related to these dimensions in order to report themes relative to these areas. In the next section, we present a selection of these emergent themes.

Results

The narratives of these educators revealed what they thought they knew about their students, and how these perceptions may have affected the decisions they made about their teaching. While most researchers use the term “learners”, we found that none of the three participants used this term, preferring to refer to learners as “students”, “kids”, or by their student status, such as undergraduates or graduates, or more specifically as freshman, sophomores, juniors, seniors, master's, or Ph.D. students. Although we did not ask participants explicitly the extent to which they considered learners in making decisions about their teaching, they all mentioned students as being an important factor in their teaching decisions. They all made explicit and implicit statements about their students. Often these statements were in the form of some characterization or observation about a student or groups of students. They routinely used these characterizations and observations about students when making decisions about their teaching.

Their discussions about students were rich, nuanced, and extensive, encompassing a significant portion of their narratives about teaching. Their characterizations and observations about students and student behavior were along multiple and complex dimensions, such as:

- Interacting with groups of students (e.g., in class or during labs and recitation sessions)
- Interacting with individual students (e.g., during office hours or through electronic forums)

- Student ratings
- Active learning strategies or pedagogies
- Academic misconduct (e.g., cheating, plagiarizing)
- Grading and exams
- Setting expectations and boundaries
- Student motivation and engagement

For the purposes of this paper, we focus our analysis on the first four dimensions across the three case studies. In the first section of the results, we explore how the three participants described their interactions with students. In the next two sections, we report on their experiences of receiving feedback from students through student ratings, and their experiences using active learning as a specific pedagogy. Finally, we report about the extent to which we could identify the source of their information about students.

Interacting with Students

In this section, we present how these three educators described characterizing students as a result of interacting with them. First, we examine how they characterized their teacher/student relationships in general. We then further compare and contrast their observations related to interacting with large groups of students (e.g., in a classroom, lab or through a course website or forum) and interacting with individual students during office hours, through e-mail, or through some other means of communication.

Teacher/student relationships: Ted, Nathan, and Fay all described teacher/student relationships as starting with mutual respect. However, within this framework of mutual respect they used two very different analogies to describe teacher/student relationships: the parent/child analogy, and the senior colleague/junior colleague analogy.

Ted and Fay both characterized their relationships with students using a parent/child analogy. They both compared raising their own children with teaching their students. Ted stated explicitly that having children made him more “aware” and “familiar” of the challenges of teaching, saying “and then once I had kids of my own, I was even more acutely aware of many of the challenges...” and “I have children of my own, so I've been familiar with that sort of teaching issue...” From this parent/child model, there seems to be a sense that Ted and Fay felt more responsibility for their students, much like a parent would feel responsible for their own child.

In contrast, Nathan referred to his students as “budding professionals” and alluded to them as junior colleagues in a mentoring relationship. He expected his students to participate in a “give-and-take” relationship and take ownership and responsibility for their own learning through asking him for help when needed. He was very emphatic about stating his expectation that students will take responsibility for their own learning, saying that he told his students,

“And I can't help you unless you tell me what you need help with. So if you're struggling with anything in this class, it's your job to tell me what you're struggling with, not my job to figure it out, because I'm not a mind reader. I'm not in the business of doing that. I'm in the business of responding to information. Provide me information, I'll do the best I can with it. So I do try to encourage

that attitude, that if you need help from me, it's your responsibility to come and ask for help. It's not my responsibility to read your mind, but it's also your responsibility to tell me what's working and what's not working.”

Aspects common to both the parent/child and the senior colleague/junior colleague analogies for teacher/student relationships were that both models acknowledged a power differential inherent to the relationship. Both analogies indicated a significant sense of responsibility on the part of the teacher regarding helping students to learn and grow. However, these two analogies differed in the type and level of responsibility that the participants assumed students should take for their own learning.

Interactions with Large Groups of Students: Ted, Nathan, and Fay all had extensive experience with interacting with large groups of students within a classroom, lab environment, or through some electronic forum such as a website or course blog. Through their interactions, they all have developed their own models for interacting with students in large groups.

Fay and Nathan used the analogy of students in a classroom as an “audience”. Fay went even further to describe a large group of students as a “paying audience”. Fay also mentioned that, “I try and have some fun with it, because it is – it's like this big audience that you – you know, they sort of have to laugh.” Nathan went on to describe the importance of interacting with an “audience”, saying

“And I also think with the teaching that there's – to some extent it's just whether you can easily communicate with the audience or not, and to some – I think that's to some extent intrinsic, that some people just are more comfortable with that than others, and so you just get up there and say, okay, what is it, you know, work the audience.”

Fay, Nathan, and Ted spoke of reading students’ body language to understand their interest (or lack of interest) in a specific topic. Nathan described students in a survey course “rolling their eyes” because of their lack of interest. Sometimes these visual observations led directly to a decision regarding students to change the pace of a lecture or course discussion, to elicit feedback directly from students to determine their understanding of a topic, or to engage students in an active learning exercise.

Interactions with Individual Students: Ted, Nathan, and Fay all mentioned that it was very important that students have access to individual help, and all regularly taught large classes with up to 200 students. However, they differed in the specifics of how to offer opportunities for access. Nathan had an open door policy about office hours, and expected students to take responsibility for seeing him and getting help if they didn't understand something. He felt that students appreciated his accessibility, and that this was reflected positively in his student ratings, saying

“That's something, office hours, I've made a decision on to have a liberal policy with office hours, which eats up a tremendous amount of time. But, you know, when you look at your evaluations – and for me, they always have these things

when they rank you against yourself and like what are the attributes of this person, and the things that come up are, you know, enthusiastic about my topic, and then the other thing that comes up is that I'm always willing to help them out. They always come up one, two, or three, always."

Fay established strict boundaries about face-to-face interaction with students and expected these interactions to take place exclusively during office hours or scheduled appointments. However, she also felt that students needed to have prompt access to expert help, and mediated individual interactions through a course website that included an electronic forum on which students could post questions to the class. She monitored this forum intensively, and felt an extreme level of responsibility and obligation to respond to student questions quickly, saying

"I try super hard to be responsive as their professor. So I – I mean so here are other things, too. I have my office hours, I very – right up at the front of the class, you know, the first day of class, I set my boundaries, I say these are my office hours. I ask you to respect them. If you need to make an appointment, you can try outside of class, but that's when I'm there. You have TAs, and otherwise if you have a question, stick it on the *[electronic forum]*... And I check that – I check that *[electronic forum]* right before I go to bed, I check that *[electronic forum]* first thing when I wake up in the morning."

Ted did not specify his level of accessibility outside of scheduled office hours. However, Ted felt that not enough of his students took advantage of the one-on-one interaction offered by office hours, and made a decision to convert a 2-hour Friday lecture session to an interactive lab session, so that students would have an opportunity for individual attention, either with Ted or his teaching assistants.

Nathan and Fay tied their level of responsiveness to individual students to positive student ratings. In the next section, we describe their views about student ratings and course evaluations.

Student Ratings and Evaluations

Student ratings are a form of course evaluation system used by the university at the completion of the quarter. By filling out the student rating forms, students can evaluate the outcomes of taking the class and the instructor's contributions to such outcomes. Mid-term evaluation is an optional form of course evaluation and can act as an addition to and complement the end of quarter student ratings. Typically, the mid-term evaluation is initiated by the course instructor with the help of a faculty developer from the university-wide or college-wide teaching centers. The faculty developer then runs these mid-term evaluations and facilitates a discussion with the students when the course instructor is absent. Once the mid-term evaluations are completed, the faculty developer meets one-on-one with the instructor to discuss the results from the mid-term evaluation and suggest strategies on how to modify and improve their teaching.

All three of our participants believed that student ratings and evaluations were a way for students' voices to be heard and validated but each of them had a different view about using such student ratings and evaluations.

For example, Ted's observations about student ratings and evaluation were negative. He reported less than "stellar ratings"; this may have contributed to his negative views. Ted described his challenges in using the results from course evaluations constructively. He also argued that "disgruntled" students and students who do poorly in a class tended to give lower ratings. He believed that sometimes students were unable to differentiate between course content and the educator's contribution to the course. He went on to explain what he viewed as challenges related to course ratings and evaluations:

"And since there are many disgruntled students, the ratings can often be very low...And they're disgruntled with the course as a whole, not necessarily with the way it's been being taught. So it's a challenge, but I like teaching this course. The material is a lot of fun, there's a lot of different ways of approaching it, and I've tried several of those different ways over the years, and tried to make my own innovations, even though there are a lot of restrictions on what I can do because of scheduling."

While Ted seemed unsatisfied with his student ratings, Nathan seemed reasonably satisfied with his. He self-reported receiving good to excellent student ratings in general. However, he still felt that there was a need to improve his ratings, specifically in a course that was related to his research interests. He was surprised that he continued to earn lower student ratings in a class for which he was personally and professionally interested. Because of these lower ratings, he decided to re-evaluate and continue to modify this graduate elective course, saying

"Is in my graduate class has been someplace where you think, well, I'm a professor, I'm real active in a certain area of research, and a graduate class ought to be the place where you get your highest evaluations. And for me it's never actually been that, and I wondered why, you know, what is it about my class..."

Fay seemed very satisfied with her student ratings. She self-reported that her student ratings were excellent. High student ratings were very important to her; she still often made explicit decisions to work with faculty developers to do mid-term evaluations in her classes. She admitted when she first started out teaching, she had received "crummy ratings" for a particular course. However, after taking one of her students' written comments in the course evaluation into consideration, she made a decision to modify the format of this course significantly and said that she had been receiving excellent ratings ever since:

"I plan to use it till I die unless they decide they hate it. I mean basically my take is I'm still teaching all the same courses. If when my teaching ratings get crummy or the students say they hate me, then I'll make some big changes, but so far it hasn't happened."

She continued to monitor her student ratings closely, and valued the results of mid-term evaluations. She reported considering student feedback from these evaluations when she made teaching decisions to adjust aspects of the course.

Active Learning

Active learning is a term that describes a specific pedagogy that engineering educators have been encouraged to use in order to engage students during the instruction and learning processes. All three of our participants talked extensively about using active learning approaches in their classrooms. However, each educator had their own individual reasons for employing active learning in the classroom.

For example, Nathan would constantly monitor his class by surveying students' facial expressions and body language. When he sensed confusion in the classroom, he described how he would stop his lecture and elicit feedback from students. He also believed that engineering students liked to solve design problems. To address this, he regularly conducted active learning exercises in class in which he elicited ideas from students about how they might apply the theoretical concepts they were learning in class to actual engineering design problems.

Often, he created design projects from his current research to better engage his students in the classroom. He described "this obvious case study that people were familiar with would also give it a little bit more immediacy." As a result, the students were getting hands on experience within their individual group projects, Nathan "felt like it was a much more gratifying experience" for him as the instructor. Furthermore, the students presented their project findings to other researchers (from industry, government and non-profit organizations) who were interested in the findings. This strategy also created a much more authentic experience for Nathan's students.

In Fay's case, she explicitly stated that she felt active learning was extremely valuable in facilitating student learning. This belief, in conjunction with a direct suggestion from a student recommending that she provide students with her lecture notes, drove a major teaching decision to publish her lecture notes in a course packet format that facilitated active learning exercises during class. Within the course packet, she wrote problem sets and examples and decided to have students work these examples in class frequently in order to keep them engaged. When the students worked on example problems in class, Fay would walk around the classroom and check on students' progress. She commented that an active learning approach was "a really nice way to get to know the students too." She purposefully left blank spaces within the lecture notes to keep students "awake" by encouraging them to take side notes while she was lecturing.

Ted was concerned that not many of his students seemed to come to his office hours. He speculated that some students didn't come to office hours because they had tight schedules and needed to work. However, he described how hard it was to get to know his students when they would not interact with him during office hours. In order to address this issue, Ted decided to turn one lecture period per week into an unofficial lab so that he could engage students during that time. He also surmised that students needed more teacher/student interaction in the classroom because "most students say if they had a choice, you know, they'd rather learn in some way other than listening to lectures all the time." He decided to choose an active learning approach to keep himself engaged because "students get bored and I get bored." He believed that "there just has to be a balance. It can't be all lectures."

While both Fay and Ted spoke openly and encouragingly about using active learning strategies in the classrooms, they had different ideas about why certain students will not speak up in class.

Ted believed that some students would not want to speak up in class because they are afraid of sticking out, or taking up class time, or for other unknown reasons. Fay believed that some students are not as participatory as others because of personality issues. For these reasons, both Fay and Ted were cognizant about inclusiveness in the classroom.

Sources of Information

Here we describe the sources—self-reported by the educators—from which they gained information about how they learned about their students. The sources of this information about students seemed to be derived primarily from their personal experiences of interacting with students and observing student behavior. Occasionally these educators used their own experience as a learner as a stand-in for students or a point of guidance when making decisions. To a lesser extent they reported obtaining information about students through discussions with colleagues. The sources of information mentioned least were campus teaching resources (e.g., teaching workshops and faculty developers) and educational literature.

None of these three educators had formal teaching training; however, they all explicitly expressed using their own experiences as an educator when making decisions about learners. They made decisions based on their overall teaching experience and understanding within a certain class. Nathan used his personal experience and knowledge of dissatisfaction about a course to change aspects of the course:

“Except, you know, in this particular place it doesn't have to because I can say we're going to follow this real strict, you know, schedule, and I haven't been completely satisfied with that class, and what I tried last year to do, which I was much more satisfied with personally, though my evaluations didn't change that dramatically, is to focus the entire class on a particular topic.”

At some point in their careers, all three described using teaching workshops as a source for gathering information. Nathan and Fay reported attending these workshops more often when they were at an earlier stage in their careers. Fay was more involved in workshops for female faculty in engineering on an ongoing basis. Ted enjoyed attending teaching workshops and stated that he continues to attend teaching and creative teaching workshops. Ted explained one of his reasons for participating in workshops, saying

“But [*Faculty member*] had a workshop on sort of creative teaching, and I took it my first year here at [*this university*], and that was just one of -- whenever I have a chance to have fun how to teach, I like to go. I mean I volunteered for your [*study*]...”

None of these educators explicitly stated using faculty developers as a source for teaching information; however, Fay and Ted used mid-quarter reviews through the university's assessment and evaluation of teaching. Mid quarter reviews allow the educator to discuss their teaching with a faculty developer, who performs the assessment and evaluation of the course.

Ted, Nathan, and Fay explicitly stated that they had an interest in teaching and related issues. This dedication towards teaching can be seen through their self-reported actions and intentions.

Ted claimed to consult education literature. However he never explicitly stated using this literature as source when making teaching decisions. Neither Nathan nor Fay explicitly mentioned using literature as a source of information about learners. All these educators used their colleagues as sources of information. When Nathan was early in his faculty career, he sought out advice from more senior colleagues:

“I’d say that when I was young – when I was first starting out here, that I would solicit a lot of advice from my more senior colleagues when I felt like I was in a situation I wasn’t quite sure how to proceed.”

In their teaching, Ted, Nathan, and Fay reported regularly eliciting student feedback. For example, Ted elicited student feedback from a few students during office hours. All three used their own monitoring of how their students were digesting course material by observing and interacting with them. This monitoring was done through reading students’ facial expressions and body language to understand if they understood the course content. They used this information in making decisions about adjusting their courses.

Discussion

In the previous section, we presented findings concerning how the educators took learner information into account in their teaching decisions. Specifically, we reported on the types of information they reported using, their use of the information, and the source of the information. We also reported how they described information in three specific areas related to students: interacting with students in large groups and individually, student rating practices, and enacting active learning strategies. We also examined their sources for this information.

The findings represent three educators and their thinking relative to a small slice of the teaching. While it would be inappropriate to generalize from these results, the results do provide a benchmark and a basis for asking future questions. One might also wonder whether the educators spoke about learners simply due to a Hawthorne effect (e.g., they believed that we expected them to talk about learners). However, there is little evidence in our data that the participants set out to please the interviewers in any particular way. For example, the participants’ comments included information that was unflattering to themselves and often startlingly frank —something that would have been unlikely if they were being deceptive.

Concerning the significance of the results, a first observation is that if the notion of learner-centered is equated to simply thinking about learners, then our results suggest that that was potentially an oversimplified question. Yes, these three educators clearly took learners into account. Attempting to align the results with the more specific notions of learner-centeredness discussed in the literature review proves more difficult. For example, thinking about the results through the learner-centered design lens of Soloway and his colleagues, we saw the educators thinking a great deal about motivation and some about growth. They also thought about diversity but mostly in the context of outreach rather than the diversity of the students in their core classes. However, the results simply do not map easily to the frameworks from *How People Learn* or Kember’s work on teaching conceptions.

In addition to mapping the results into visions of learner-centeredness, we can also consider using the results to identify implications for research and dissemination practices in engineering education. For example, given the result that the educators did not report getting information from education literature, this suggests that the researchers need to consider mechanisms other than conference publications and journal articles to get their research into the hands of the educators.

It is also possible to look at results with respect to strengths and areas for concern. The results suggest that a core strength of the educators' processes is that they are already thinking about learners. This becomes something faculty developers can build on when designing activities to help educators become more effective. Further, while their knowledge is unvalidated, it is potentially a source of information to share with the result of the engineering education community. At the same time, their portrayal of students raises some concerns such as whether the educators possess unchecked information, even theories, about their students and whether the sometimes negative characterizations of their learners were inappropriate.

Finally, it is possible to look at the results with an eye toward future research. One issue that is of potential interest is to look further into the form of the educators' knowledge about their learners. At times, the information came across as factoids, at other times like information from a holistic theory about students. From a faculty development perspective, factoid-type information would be easy to update while theory-like information would be harder to address. A related issue comes from considering the importance of all three of educators discussing issues related to the areas of student ratings, large classes, one-on-one interactions, and active learning. These four areas seem significant in that they represent explicit links to teaching and thus potentially useful ways for the educators to organize knowledge about teaching. They even suggest the possibility of a new concept—contextualized learner knowledge. Another issue is the issue of whether their information is correct. While a lot of the information they present is congruent with commonly accepted findings about students, other information seemed incongruent. At the same time, given the educators are talking about *their* students, in *their* classes, and in *their* departments, it seems hard to evaluate the accuracy of the information. Collectively, these are topics for future research.

Conclusions

Teaching decisions represent a context for the use of information such as student diversity, student prior knowledge and misconceptions, and learning styles. We used narratives about teaching decisions from three educators to explore issues of how engineering educators take learners into account. Our results support moving the conversation from a question of whether educators take learners into account to a question of how educators take learners into account. Future publications will focus on how the themes represented in this paper play out across the other thirty educators represented in our dataset.

This work contributes to efforts in the engineering education community to promote effective teaching by raising questions about what educators are currently doing and benchmarking what they are doing. These results complement the bodies of information being created concerning how we want educators to teach and the information available about who engineering students are and how they learn. The work contributes more broadly to efforts to understand and model

teaching practice. The vision of teaching pursued in this research complements and complicates images of teaching present in other work.

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