2006-2166: DECISION-MAKING: WHAT DOES IT HAVE TO DO WITH MY TEACHING?

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Abstract

Engineering education is a complex design activity where educators create a range of teaching artifacts including course curricula, classroom policies, lecture notes, exams, and timelines for student group projects. In order to design such artifacts, engineering faculty must make a series of teaching decisions, each of which can impact their students' learning and engagement with course activities. Given the importance of decision-making in engineering education, we hope that by beginning to characterize engineering educator decisions, educators will gain a greater awareness of decision-making by recognizing, characterizing and anticipating decision points. In this paper, we report the results of an exploratory study of engineering faculty's decisions as expressed during the instructional development process.

Introduction

> Dr. Andy Nguyen is a new engineering faculty member starting his first job at a large university. During his time as a graduate student he mostly worked on research and hasn't taught a class for a couple of years. Now, as he starts his career as a faculty member, he is preparing to teach a course on computational fluid dynamics. Although he attended some teaching workshops and read up on teaching practices, he feels overwhelmed at the prospect of teaching. The department chair has given him a sample syllabus and some suggestions on textbooks, but Dr. Nguyen still has to determine how to plan the day to day lessons to teach. He wants to make sure that the classes he teaches are effective for the students, but also since several of his colleagues will visit the class this first quarter, he wants to make a good impression on them too.
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> Dr. Doris Johnson teaches a required engineering course with over 100 students. She has taught the class a number of times before but this time has noticed that her students don't seem to be paying attention. During the lectures, they talk amongst themselves, a few fall asleep, and as the semester progresses, she notices that attendance is slipping. Dr. Johnson knows that this material is essential for the students' future success in their coursework and careers as engineers. She's afraid that the students will not be prepared and that this may reflect poorly on her. Thinking about the class lectures, she wonders what she can do differently to better engage her students both this quarter and next time she teaches the class.

Each of these scenarios highlight some common challenges that engineering educators face. Engineering education is a complex design activity where educators create a range of teaching artifacts including course curricula, classroom policies, lecture notes, exams, and timelines for student group projects. In order to design such artifacts, engineering faculty must make a series of teaching decisions, each of which can impact their students' learning and engagement with course activities.

Some anecdotal observations suggest that engineering educators are aware of teaching as a decision-making activity. However, some faculty may not think about the number of decisions they make on a daily basis. For example, when faculty lecture they have decided upon a particular teaching strategy and subsequently are not engaging the many other instructional options that are available to them. When instructors are not aware they are at an important decision point, creative opportunities for increasing quality of instruction and teaching expertise can be lost. Even if they are aware of the decisions that they make, they might not be aware of the decisions that their colleagues make. There are benefits to understanding the decision-making processes that your colleagues make because you will then be able to better recognize and prepare for similar decision-making situations.

It is important to define what we mean by teaching decision-making. Sutcliffe and Whitfield[1] have defined a teaching decision as "a decision made during the execution of the professional responsibilities of the teacher" (p. 16). Our definition of teaching decision also references the notion of "a decision as a commitment to act. Action is therefore the irrevocable allocation of valuable resources.[2]"

From a psychological perspective, decision-making is a subjective activity, making it difficult to research directly. Researchers cannot "see" or "witness" a decision, and therefore must infer from observable behavior or participant comment 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 researching decisions have contributed to the paucity of studies that examine teacher thinking, teacher conceptions and teacher decision-making.

Despite these challenges, educational scholars like Shavelson and Stern[3] clearly state the need for this type of research, especially regarding teachers' pedagogical thoughts, judgments, decisions and how these are linked to their behavior. They believe that any model that is solely behavioral is conceptually incomplete, not accounting for the predictable variations in teachers' behavior arising from differences in their thoughts, judgments, and decisions. Shavelson and Stern also indicate that empirical research linking teachers' intentions to their behavior can provide a sound basis for educating teachers and implementing educational innovations.

Moreover, decision-making has important links to general teaching expertise. O'Hare, et al. (1998), basing their work within the critical decision-making model, suggest that experts draw from a wider range of past experiences than novices for a given decision point. In other words, experts can rapidly differentiate the many implications inherent in a particular decision point, prioritize possible outcomes, and choose the best course of action possible given the situation. O'Hare, et al. suggest that novices should be directly trained to develop the perceptual differentiation skills used by experts in the decision-making process.

Given the importance of decision-making in engineering education, we hope that by beginning to characterize engineering educator decisions, educators will gain a greater awareness of decision-making by recognizing, characterizing and anticipating decision points. Thus, the initial research questions driving this study were as follows:

- What aspects of engineering educator's decision-making processes are prominent during their participation in the instructional development process?
- How can engineering educators make more effective decisions?

In this paper, we report the results of an exploratory study of engineering faculty's decisions as expressed during the instructional development process. First we will describe the study itself, our use of qualitative coding methods, and our data analysis process. Next, the results of the study will be presented as well as a discussion of their possible ramifications for educators. Finally, we offer suggestions focusing on how engineering educators can become more aware of their decision-making capabilities in order to engage in effective teaching practices.

Methods

This current study is based on the secondary use of existing data from an NSF-funded study of the teaching challenges of engineering faculty[5]. Participants in this study were engineering faculty at a Research Extensive university on the West Coast who sought out assistance through the instructional consultation process. An instructional consultant was debriefed after consultations with individual engineering faculty and teaching-related groups with the resulting transcripts anonymized to protect the identities of participants.

From our previous experience with this data, we knew that the transcripts contained both explicit and implicit information about educator decision-making in the consultation context. The participants in this study were highly motivated and engaged in their teaching practices. They were also very active in terms of seeking expert help from the instructional consultant to deal with teaching related decisions. While the secondary use of data comes with a number of caveats, including issues of reliability[6], we felt this exploratory study would be a promising start in a larger investigation into engineering educators' decision-making.

We purposefully selected 10 of the transcripts from this data set, which were diverse in subject matter, involved different types of teaching activities, and contained visible educator decision points. All of the selected transcripts included prominent and specific educator teaching issues. Three coders used a qualitative coding technique[7] to identify and characterize key decision points in the data. They analyzed the transcripts and increased reliability by comparing their coding results and negotiating differences. From the 10 transcripts, we identified 77 decision points which ranged from a faculty member deciding about how to deal with a difficult student upset about her grading to a faculty member deciding how to assess the effectiveness of his experimental teaching methods on student learning.

We recognized decision points in the data by identifying language in the transcripts consistent with:

- A commitment to a course of action
- A description of a previously made decision

Once a decision point was recognized, we also characterized it by noting the circumstances that prompted the decision, the discussion of possible alternatives, and possible ramifications. Finally, based on our analysis of the decision points, we created three additional coding categories for which we assigned numerical values. For ease of reading, these codes will be explained further in the Findings section.

The following section of this paper presents the results of our data analysis process.

Findings and Discussion

In reporting our results, we first provide a brief description of the range of teaching-related decision points identified in the selected consultation debriefing interviews. We will then describe the three coding categories which resulted as a part of operationalizing our initial research questions, including our interpretation of our findings.
According to our data, engineering educators discussed a wide range of teaching decisions with the instructional developer. From these teaching decision-making scenarios, we were able to identify, code, and characterize a total of 77 teaching decision points from the debriefing transcripts. For example:

- Faculty member deciding about how to deal with a difficult student upset about her grading.
- Faculty member deciding to better the climate of his classroom by learning more about diversity issues.
- Faculty member deciding to work with the instructional consultant to improve the Broader Impacts section of a grant proposal
- Faculty member deciding to gather data from his students about the effectiveness of his Just-in-Time Teaching methods.

Teaching decision points

Over the course of our qualitative coding process, the research questions driving the analysis became focused on:

- Magnitude: How many students will be affected by this decision?
- Immediacy: How immediate was the impact on students?
- Motivation: What is the motivation for making this decision?

Each of these three dimensions was evident in the selected consultation debriefing interviews. The following sections describe each dimension in greater detail, as well as reporting our findings and our interpretation of our findings. Figures 1 through 3 also illustrate the relative frequency of the coded decision points reported under each of these dimensions. These graphs will better enable us to understand the examples of teaching-related decisions and decision points that were illuminated by our engineering educators.

Magnitude of the teaching decisions. The Magnitude dimension addressed the participants' perceptions of the number of students that appeared to be affected by a particular decision. There were six coding categories connected with this first dimension: (1) individual student, (2) single class, (3) all current and future students of a single course, (4) all the students I teach, (5) all students in my department, and (6) all students. These categories were arranged in order of increasing magnitude as illustrated in Figure 1. In order to code the magnitude level for a particular decision, the researchers took into account the general goals of the consultation as well as participant comments about future possible ramifications. When the number of students was not adequately described, we chose the more conservative approach in the following coding categories:

1. **Individual student.** This code captured decision points that educators made that may impact a single student. For example, one educator decided to seek alternative strategies in order to become a better mentor for a particular graduate student.

2. **Single class.** This code captured decision points made that could impact all the students in a particular class. One educator, for example, decided upon a specific type of classroom evaluation method that would be most appropriate for students in a given class.

3. **Current and future students of a single course**. This code captured decision points that would impact students in both the educators' current class as well as students taking the same course in the future. For example, one educator made a series of decisions about framing, introducing, and implementing a new late assignment policy for a particular course.

4. **All the students I teach**. This code captured decision points that could impact all the students the educator teaches, undergrads and grad students, research labs and traditional classrooms. One educator decided to attend a teaching-related workshop in order to learn new teaching strategies he could incorporate into his teaching repertoire.

5. **All the students in my department**. This code captured decision points that could possibly impact all students within the educator's department. For example, one department chair decided to assist in designing, implementing and modeling mentoring relationships with undergraduates, graduates and junior faculty members. Such an approach would eventually affect all the students in the department.

6. **All students in the college.** This code captured any decision points that educators made that would impact all students in the college including those that they had no direct contact with. For example, one faculty member while seeking assistance in writing a large research grant proposal considered options that would create potential learning opportunities for all students.

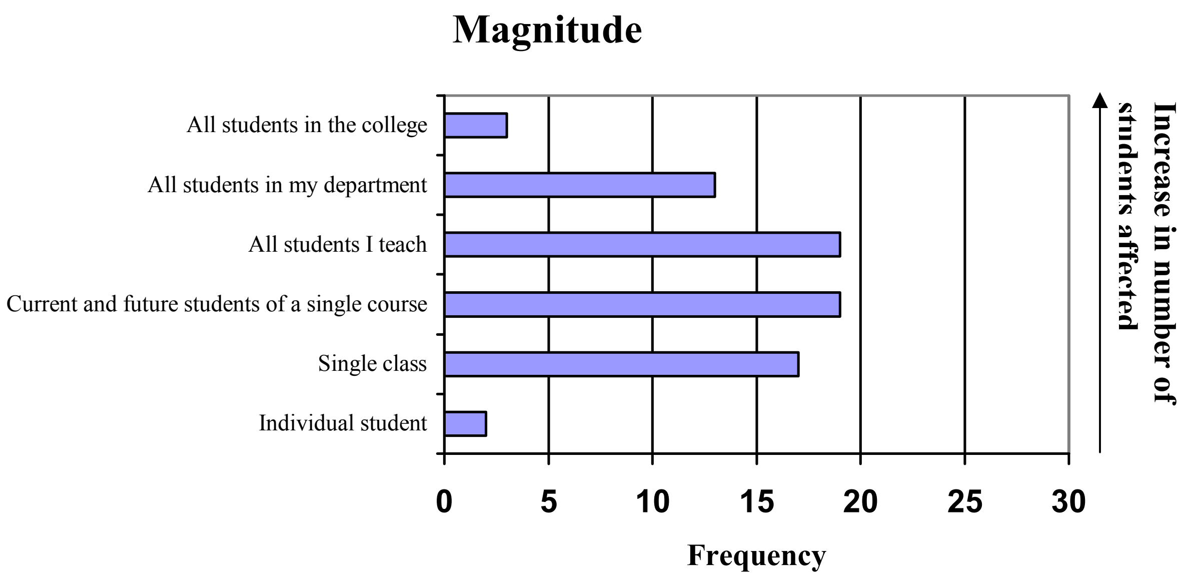

Fig. 1. How many students will be affected by this decision?

Discussion of Magnitude findings. In relation to magnitude, the participants in this study appeared to focus on more global decisions rather than those related to a single student or a single class. Nearly 70% percent of the coded decision points related to impacts affecting large groups of students:

- Current and future students of a single course (26%)
- All the students I teach (26%)
- All students in the department (17%)
- All students in the college (3%)

The two remaining categories included individual student (3%) and single class (22%).

This global perspective for decision-making includes two aspects: taking a future orientation and having a systems perspective of student learning. First, our data suggests that engineering educators may take a future orientation when making decisions about specific events or circumstances, with 52% of the decisions concerning current and future students of a specific class (26%) and all the students I teach (26%). In addition, these faculty are engaged with decisions that involve seeing students as part of a larger education system, with 20% of decisions concerning to all students in the department (17%) and all students in the college (3%). These findings suggest that engineering educators, while faced with decisions regarding a specific situation, may also adjust the decision according to the wider implications to students and to the educational system in which they operate.

Immediacy of the decision. Instead of the number of students involved, the Immediacy dimension addressed whether a decision would have an immediate impact on students or whether another intermediary activity would need to be performed before students were affected. There were six coding categories associated with this dimension: (1) classroom management, (2) curriculum design, (3) teaching development, (4) networking, (5) grant writing, and (6) research on engineering education. These categories were arranged in order of increasing immediacy as illustrated in Figure 2. The coding related to this dimension involved categorizing the outcomes of each decision according to the following criteria:

1. **Classroom management**. This code captured decision points that the educators encountered when exploring strategies to make their classes run more smoothly. Once the decision is made, it will impact students immediately or very soon. For example, we saw an educator deciding how to respond to a late assignment turned in by one of her current students and wanting to implement the decision immediately.
2. **Curriculum design**. This code captured decision points that the educators encountered while trying to improve curriculum structure. Once the decision is made, it will impact students soon. For example, we observed an educator deciding the best way to redesign a final course project based on students' feedback from the mid-term evaluation. The resulting decision would impact both current students this term and future students when the educator teaches the course again.
3. **Teaching development**. This code captured decision points that the educators encountered while trying to improve their teaching. For example, an educator encountered a decision point after taking a workshop about incorporating active learning into science and engineering classes. The educator was trying to decide where and when to implement these new techniques in his class. The resulting decision might not impact students in his current class, but will impact students in future classes.
4. **Networking**. This code captured any decision points that the educators encountered while trying to create collegial relationships with peers, administrators and those in industry. For example, one faculty member decided to learn more about her departmental and college culture from her colleagues so that she could better fit into her department.
5. **Grant writing.** This code captured decision points that the educators encountered while writing research and educational grants. For example, an educator writing a grant proposal requested funding to update a lab. The decision could impact all undergraduate and graduate students in his department the following year.
6. **Engineering education research.** This code captured decision points that the educators encountered while conducting research on the engineering education process. Student impact related to this research, especially when experimental or ethnographic, could take a considerable amount of time to manifest.

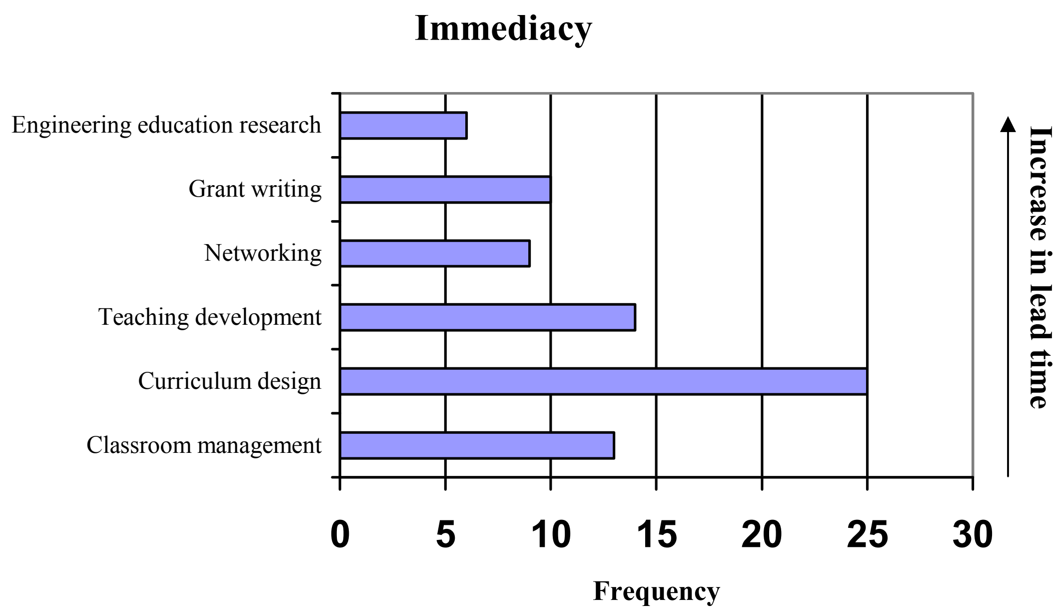

Fig. 2. What is the immediacy of how this decision will affect students?

Discussion of Immediacy findings. The findings in this dimension suggest that study participants in the instructional development process focused primarily on activities which will have a direct impact on students. Nearly 66% of the decision points involved activities traditionally related to teaching:

- Classroom management (16%)
- Curriculum design (32%)
- Teaching development (18%)

These percentages, however, do not reflect the range of decisions falling into each category. Curriculum design, for example, includes decision points ranging from the design of a single classroom exercise to the creation of a cross-department sequence of classes. This emphasis on decisions related to traditional teaching activities both underscores educators' commitment to quality teaching and suggests that the educators in this study actively sought out ways to increase their professional skills.

On the other hand, 31% of the decision points involved activities which would eventually impact students, but only after lead time related to intermediary stage of activity:

- Networking (11%)
- Grant-writing (13%)
- Engineering education research (7%)

These percentages demonstrate an aspect of instructional consultation that may not be readily apparent. Participants in this study engaged decisions during their consultation related to: enhancing departmental, collegial and industry relationships; writing the education-related sections of grant proposals, and conducting research in their own classrooms aimed at contributing the engineering education knowledge base. Although these decisions may not have immediate impact on students, they represent vital aspects of an engineering faculty career.

Motivation for making the teaching decisions. The Motivation dimension was based on whether the decision point was generally framed as a difficult situation that must be rectified or as an opportunity for improvement. There were three different coding categories connected with motivation as illustrated in Figure 3: (1) proactive, (2) reactive, and (3) unknown. In order to code along this dimension, we took several aspects of the decision point into account, including the impetus for making the decision and the language used to describe the decision itself. These categories are described as follows:

- **Proactive.** This coding category captured decision points included educators satisfying their curiosity about a teaching method, planning a positive outcome for students, and pursuing teaching expertise. For example, one participant was curious about how to implement a new teaching technique that he had learned from a teaching workshop.

- **Reactive.** This coding category captured decision points ranging from needing to respond to an immediate crisis, an impending problem situation or discontent with challenging teaching and learning situations. For example, one participant made a series of decisions driven by the need to immediately address important disability-related issues that a student raised late in the term. A less reactive example, framed as discontent, involved an educator attempting to improve a classroom activity that had not gone well the previous quarter.

- **Undetermined**. This coding category captured decision points where motivation was not clearly specified.

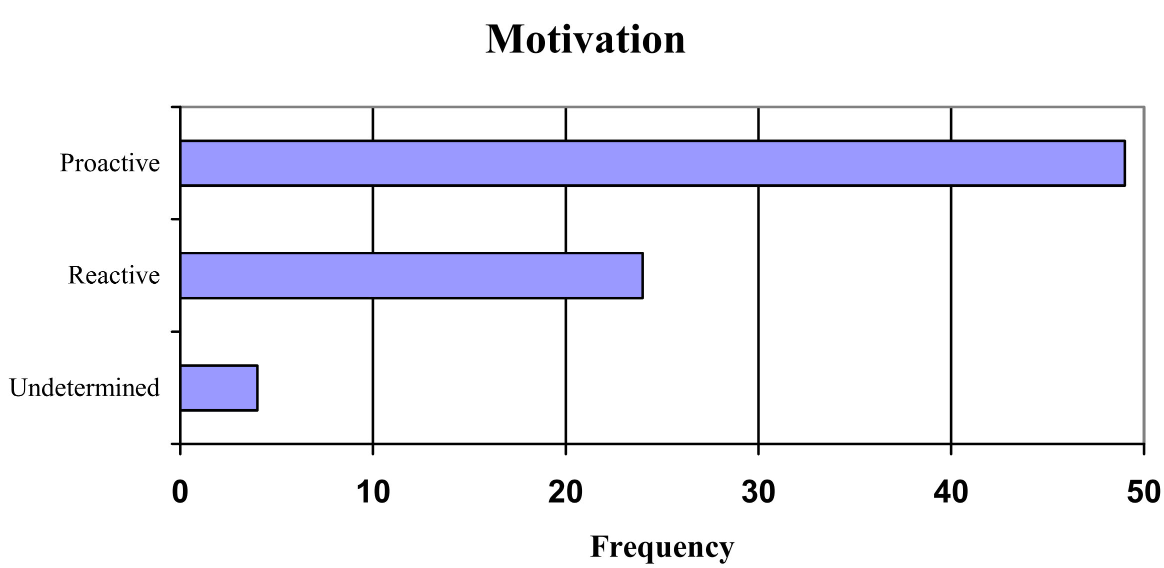

Fig. 3. What's the motivation for making this decision?

Discussion of Motivation findings. The majority of decision points coded in this dimension were framed with a proactive approach to decision-making (63%), with the 31% of the decisions framed as reactive and 5% framed in a such way that we could not determine which category belonged in. This finding suggests that participants used the instructional development process as a venue in which they could gain skills and knowledge essential to increasing their expertise.

This finding, however, may involve an overestimation of proactive decisions because of the nature of the instructional consultation itself which is intended to help engineering educators achieve positive outcomes. The instructional consultant, as observed by the interviewer, tended to frame her clients' responses in a positive manner. Thus, our data may showcase a larger portion of proactive teaching decision points than is warranted.

Suggestions

From our data analysis, we offered glimpses of engineering faculty teaching decision-making processes that were not so readily available. In particular, we have provided a description of the range of teaching decisions that transpired during the instructional consultation debriefing interviews.

We believe that the results of the current study can help new engineering educators engage more effectively in teaching-related decision-making. In particular, we believe the results of this research can be used by educators to so that they can more effectively recognize, characterize and anticipate the teaching decisions that they will make (or are already making). This, in turn, can lead to them more efficiently acquiring relevant information, seeking expert assistance when needed, and ultimately making explicit and sound decisions and continuously refine their instructional choices. We close below with a series of tips that reflect the general and specific results of our study and the three issues of recognizing, characterizing, and anticipating. In identifying these tips, we returned often to the idea that the educators reflected in our data were actively engaged in efforts to improve their teaching and thus our profile of their decisions represents a benchmark against which other educators can reflect on their own activity.

General

As a general level, we identified a range of decisions and found it fruitful to characterize these decisions in terms of magnitude, immediacy, and motivation. This suggests the following tips:

- Be prepared to be confronted with a wide range of decisions and actively seek ways to recognize, characterize, and anticipate these decisions.
- Consider characterizing decisions in terms of magnitude, immediacy, and motivation since these ways of thinking about the decisions may help in prioritizing them and in seeking support for making the decisions. This may be particularly helpful to a new engineering educator who may benefit from ways to think through and prioritize a given decision.

Magnitude

Our process included characterizing decisions on their magnitude, which was operationalized as the number of students who potentially might be affected by the decision. For example, about 67% of our participants indicated that they were engaged in making classroom management, curriculum design and teaching development type of decisions. However, our data also showcased other types of decisions such as networking, grant writing and research on engineering education that can also be a part of teaching decision-making. This suggests the following tips:

- Be aware that decisions have different magnitudes and use ideas about magnitude to think about the potential importance of individual decisions. For example, decisions with the potential to affect all students (large magnitude) may not seem as pressing but could be considered of high importance because of the potential for impact.
- Anticipate or proactively seek out decisions about teaching that go beyond individual students and/or students in specific courses. The educators represented in this sample (who generally were educators who were trying to improve their teaching) were engaged in making decisions beyond the level of courses. As such, it is advised that new engineering educators consider the importance of such decisions.

Immediacy

Our process also included characterizing decisions on the immediacy of their impact on student learning, or alternately, the lead time required before the decision might have an impact on student learning. Again we found a bias toward decisions with short lead times (e.g., classroom management decisions, curriculum design decisions) but also evidence of decision-making relative to decisions with long lead times (e.g., decisions about engaging in teaching development, networking, grant writing, and engineering education research). These results suggest the following tips:

- Be aware that decisions have different immediacies (or lead times before they impact students) and use ideas about immediacy to think about the potential importance of individual decisions and/or to prioritize decisions. In particular, decisions associated with long lead times (e.g., decisions related to teaching activities in grant writing) may not seem as important as decisions with immediate outcomes. However, the educators represented in this sample (who generally were educators who were trying to improve their teaching) were engaged in such decisions.
- Be aware that colleagues are making decisions with more prolonged lead times (less immediate impacts) and use this information to anticipate the possibility of having to make such decisions in your career.
- Think about the potential relevance of decisions with less immediate impacts.

Motivation

Finally, our process included characterizing decisions based on their motivation. Our findings suggested that the engineering educators in our sample tend to make more proactive decisions rather than reactive. These results suggest the following tips:

- Try framing or even working toward proactive rather than reactive decisions. Striving to make proactive decisions may lead to less frustration and may lead to larger magnitude (because of anticipating and preparing ahead of time).

- Use the results of this study as one benchmark for guiding your own idea of an appropriate balance between proactive and reactive decisions. In other words, while the results from this study did acknowledge the presence of reactive decisions, the results also indicate a greater presence of proactive decisions.
- Reflect on whether you are making proactive or reactive decisions. In particular, if an educator makes only reactive decisions stemming from crisis type situations, then they should consider taking the proactive approach because it may reduce stress and lead to better outcomes.
- Use the results of the previous two ways of characterizing decisions to anticipate the range of potential teaching decisions you might encounter, thus paving the way for greater proactive decision-making. In other words, the more an educator is able to, at minimum, anticipate decisions, the less likely it is that that educator would be taken completely taken by surprise and thus put in an extremely reactive mode. Decisions that have been anticipated in advance, even if currently triggered by a crisis, may be easier to reframe in proactive way.

Next Steps

The present study is built on a data set that focused on teaching challenges of engineering faculty.[8-10] Because the interview protocol was originally designed for eliciting challenges rather than decisions, we were not able to address the question of "effective teaching decisions" directly. However, we are currently conducting a research study that has a specific focus on effective engineering educator's decision-making process so we can glean more ideas and information on making effective teaching-related decisions. More tips on making effective teaching decisions will be built on in the next study.

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