AC 2010-1107: HOW STUDENT-FACULTY INTERACTIONS INFLUENCE STUDENT MOTIVATION: A LONGITUDINAL STUDY USING SELF-DETERMINATION THEORY

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How Student-Faculty Interactions Influence Student Motivation: A Longitudinal Study Using Self-Determination Theory

Abstract

Through the National Survey of Student Engagement (NSSE) and other sources we have quantitative measures of student-faculty interactions and we know that such interactions impact learning. Yet we know little about the quality of these interactions or how such interactions impact students' motivation. Grounded in self-determination motivation theory, this research begins addressing this gap using interviews with students to explore students' perceptions of interactions with faculty and how such interactions impact students' autonomy, competence and relatedness beliefs. The interviews, collected annually with each participant for four years, were analyzed using multi-case methods. The results of our analysis across all four years show that students' feelings of autonomy-support decrease after the first year, that students do not generally describe competence supporting behaviors by faculty, and that students are generally positive about relatedness with faculty other than in the third year. Over all four years, more women report positive relatedness than men, while men are much more likely to report neutral feelings or not discuss the topic. The primary implication for practice is the need for faculty to be more aware of the many unintended ways their actions can influence students.

Introduction

Recent research has emphasized students' needs to feel connected to others and to build relationships within the engineering community, including engineering faculty members.[1] As part of the undergraduate education process, faculty guide students through thousands of hours in classrooms and laboratories. To design better educational experiences for engineering students, faculty must understand how students perceive these interactions and how such interactions contribute to engagement in learning. Using self-determination theory [2] and analyzing longitudinal interview data, we explored students' perceptions of interactions with faculty and how these interactions changed during their four undergraduate years.

Literature Review

Self-determination theory (SDT) posits the importance of socio-contextual factors in human motivation.[3, 4] In learning environments, socio-contextual factors include social aspects such as relationships with teachers and faculty. Social aspects of learning are important but are infrequently studied. In a review of social motivation and the classroom social environment, Patrick, Anderman, and A. M. Ryan[5] concluded that more research is needed to understand how social aspects of the classroom, including the role of the teacher, positively and negatively contribute to students' motivation and engagement. Research that does exist focuses on the social aspects of learning and student motivation and has typically been limited to primary and secondary school children.[6] There is little research examining the social aspects of learning in college and particularly the role of faculty in students' motivation and engagement in learning.

This research begins addressing this gap using SDT to examine students' perceptions of being supported by faculty as engineering undergraduates.

Self-determination theory suggests that people are motivated to engage in activities, such as learning, to satisfy their basic needs to be autonomous, competent, and related to others [3, 4]. Autonomy is the need to feel a sense of control or agency. Competence is the need for mastery. Relatedness is the need to belong to a group. In college learning environments, many factors can influence students' feelings of autonomy, competence and relatedness. The actions of faculty, and more importantly, students' perceptions of these actions, are significant factors in shaping students' feelings of autonomy, competence and relatedness.[7] For example, college students who feel autonomous might say that faculty provide sufficient tools and guidance for students to learn the material on their own. Students feeling supported in efforts to achieve competence might describe faculty as encouraging them and providing additional learning opportunities outside the classroom. Students feeling related to faculty might say that the faculty made time to meet with them, and were aware of their learning needs.

Students' needs for autonomy, competence and relatedness do not remain fixed over time; they change as part of the developmental process. Research suggests that student engagement in learning is encouraged when the learning environment matches students' developmental stage. For example, Midgely and Urdan[8] describe a "developmental mismatch" with the middle-school environment being developmentally inappropriate because children at this age want more autonomy yet the classroom structure often gives them less control. Compared to elementary school, middle school classrooms tend to include less student-teacher relationship building, more controlling and less autonomy support from teachers, less individualized instruction, and less cooperative learning, which can all lead to students feeling alienated and create academic disengagement[9].

The transition from high school to college can be similarly described. Unlike small high school sessions, engineering classes are often very large, lecture-style classes. Consequently, many engineering students experience relatively little student-teacher relationship building and less individualized instruction, but more controlling settings created by the need for uniformity in assignments and grading. This presents a potential mismatch between students' needs and expectations and the learning environment. Since we know that relationships and classroom engagement-factors are critically important in college student development, persistence, and academic success[10-13], it is important to better understand this potential mismatch in students' needs for autonomy, competence, and relatedness and the college learning environment.

Through the National Survey of Student Engagement (NSSE), we have quantitative measures of student-faculty interactions such as how often students interact with faculty[14] and we know that faculty contribute to overall engineering student engagement in learning[1]. Through the work of Cabrera, Colbeck and Terenzini in developing performance indicators for assessing classroom teaching practices and student learning among engineering students, we also know that instructor interaction relates to gains in learning[15]. Yet, we know little about the quality of student-faculty interactions[16] or how such interactions impact students' motivation.

We take a qualitative approach to begin addressing this knowledge gap. Specifically, we use multi-case study methods to qualitatively and inductively analyze longitudinal interviews to address the research question: How do students' perceptions of faculty behaviors influence student feelings of autonomy, competence, and relatedness over the four years of the students' undergraduate engineering education experience? Grounded in the student perspective, our research uses interviews with students as the primary data source. Taking a student perspective is particularly important in light of recent research which shows a need to more clearly separate student perceptions from those of researchers in understanding motivational factors in learning environments.[6] In particular, research grounded in SDT has found differences in factors identified as important to students in comparison to researcher assessed methods.[17-19]

Methods

To guide our research, we used case study methods[20, 21] in combination with the self-determination theoretical framework. In our work, each participant represents a case and we analyze within and across cases.[22] The cases include eleven engineering students at a predominantly technical school (TPub) in the western mountain region of the United States. TPub is a public research university devoted to engineering and applied science. Approximately 2,500, or 75 percent, of the 3,300 students are undergraduates, and about 80 percent of bachelor's degrees earned annually are in engineering. Data for this study include 43 interviews in total, one with each participant for each of four undergraduate years. One student left TPub after her junior year, and was therefore only interviewed three times. By using multiple cases we can provide additional context for individual cases, [20, 22] greater transferability of results,[22] and potential generalization to theory.[21] Given the small sample size and characteristics of the research site, we recognize that broad generalization is limited and focus on potential generalization to theory.[21]

Participants

This research analyzes data collected through the Academic Pathways Study (APS), a multi-institutional, multi-method study conducted by the Center for Advancement of Engineering Education (CAEE). Detailed information on APS can be found in the literature.[23, 24] APS was designed to allow researchers to understand the experiences of undergraduate students as they learn engineering, including skill development, identity development, and the eventual transition to the workplace. The current study involves a subset of APS participants at one institution, TPub. By limiting this study to one institution, the potential variability due to different campus environments has been removed. This meets Stake's (2006) suggestion that case study research incorporate sufficient diversity to explore the phenomenon of interest without having overwhelming diversity.

A variety of methods were used to recruit participants at TPub, and participants were paid for their time.[25] As women and minority groups are frequently underrepresented in engineering, researchers deliberately oversampled for these groups from the pool of volunteers. Since APS is a multi-method study, not all of the participants participated in all of the data collection activities. Those chosen for this study each participated in annual semi-structured interviews. Four interviews were available for ten of the eleven participants; Julie had only three interviews

because she left engineering and TPub after her third year. Using pseudonyms, participant demographics are presented in Table 1.

Table 1: Participant Demographics

Participant	Gender	Ethnicity	4th Year Cumulative GPA[a]
Max	Male	White	3.23
Mark	Male	Half Native American/ Half White	2.74
Will	Male	Caucasian/ Part Caribbean	2.96
Tim	Male	Chinese/ Caucasian	3.14
Joe	Male	Caucasian	3.07
Anna	Female	Hispanic	3.71
Hillary	Female	Caucasian	3.91
Beth	Female	Hispano[b]	3.38
Marie	Female	Caucasian	3.91
Leslie	Female	Caucasian	3.92
Julie	Female	Asian American	2.75 (3rd year)

[a] Obtained from students' transcripts,
[b] Participant intentionally chose Hispano over Hispanic or Latina, because Hispano is a term internal to her culture rather than externally created and applied.

Data Collection and Analysis

Data for this study comes from a series of one-on-one semi-structured interviews approximately two hours in length with each of the 11 participants. Starting in their first year at TPub, each participant was interviewed in the spring semester for four years (three years for Julie who left TPub after her third year). The semi-structured interview format allowed the students to respond freely and allowed the researchers to follow-up on responses and probe deeper as needed. The interview protocol included guiding questions prompting the students to think about topics central to the overall APS objectives if such topics did not rise naturally in conversation. Interviews were analyzed in their entirety. Questions related to good and bad learning experiences, things that have been easy and/or hard at TPub, and typical daily schedules provided the most pertinent information for this analysis. Asking students to describe their day yielded particularly informative responses because students would frequently describe each of their professors' personalities, teaching styles, and course management as they told the interviewer about their schedules. Specific questions from the interview prompt that were the most useful for this analysis included:

- Have you had academic experiences here that you would describe as particularly good? Can you tell me about one of those?

- Have you had academic experiences here that you would describe as particularly bad? Can you tell me about one of those?

- How would you describe yourself as a student?
- What would you say has been the most difficult thing for you hear so far? How did you handle that?
- What has been easy for you here so far?
- What kinds of things do you think about when you're deciding what classes to take?

Each interview was audio-recorded and transcribed verbatim. The interviews (a total of 43; four for each of 10 participants and three for Julie) were then coded using MAXQDA software. Our analysis approach was guided by Miles and Huberman's [22] cross-case analysis with a variable-centered approach. In this approach, the variables have central importance over the individual cases. This means we looked at overall patterns among the variables rather than individual stories. In this analysis, the variables included the SDT constructs of autonomy, competence and relatedness.

Initially, interviews were coded for any instances where participants mentioned faculty members in conjunction with their experiences learning engineering or being an engineering student. For example, "I think that my best experience so far has been this [specific course name]. I mean, it's completely well thought out. The professor knows what he's talking about. He likes what he's talking about. The labs are coordinated with what's happening in the lecture. It's all just a very good experience. (Joe, Junior)" would be coded as "Faculty". The first author conducted the majority of the coding, in collaboration with the second author. These two authors then individually reviewed all of the coded excerpts and identified whether the students were describing positive, neutral, or negative experiences. Each excerpt was also identified as relating to the student's feelings of autonomy, competence, and relatedness. Our final code book is shown in Table 2.

Table 2: Code Book

Construct	Described Behaviors
Autonomy	
Supportive	Faculty provide adequate tools and guidance to learn material on one's own
Antagonistic	Students perceive mismatch between course and test content, believe lectures, notes, etc. are poor.
Competence	
Supportive	Faculty offer encouragement, invite students to work with them
Antagonistic	Faculty set students up to fail, will not admit own errors
Relatedness	
Supportive	Faculty make time to meet with students, are understanding of student needs, and engage students both in and out of the classroom
Antagonistic	Faculty are too hard to get in touch with, do not understand student needs, and students feel disconnected

In the final phase of analysis, we inductively uncovered patterns related to autonomy, competence, and relatedness. Ratings were then assigned to each of the participants as experiencing predominantly supportive (S), antagonistic (A), or no interactions (N) with faculty. These ratings are consistent with other SDT research[2]. Supportive means the student found the faculty behavior to be positive towards achieving autonomy, competence or relatedness, while antagonistic means the behavior was perceived as a detractor. The ratings are a combination of quantity and quality of responses. For example, a student who talks a lot will make more statements while a quieter student may make fewer but more powerful statements. It is also noted that many students had both positive and negative experiences. The rating was assigned based on the predominant experiences. The authors individually rated each participant for each year, and then compared there ratings and discussed discrepancies until a consensus was reached. We then looked at changes in the student ratings across time.

Results

Overall results show that autonomy, competence, and relatedness beliefs change over the four undergraduate years, as shown in Table 3. Total counts of participants reporting supportive (S), neutral/none (N) and antagonistic (A) behaviors are reported for each year for each category. Additionally, an overall trend rating is assigned. This overall rating accounts for the pattern across cases and is simply a count of total numbers. Finally, the trends are described in words as the last line of the table. This trending format is consistent with our variable-centered analysis approach[22] where the variables are of central importance over the individual cases. Individual ratings for each student for each year are included in the appendix. Immediately following the table, general trends are described by category. Detailed examples and participant quotes then follow, also by category.

Table 3: Summary Table of Student Rankings

	Autonomy				**Competence**				**Relatedness**			
	Year				Year				Year			
Responses	1	2[1]	3[2]	4[3]	1	2[1]	3[2]	4[3]	1	2[1]	3[2]	4[3]
Supportive (S)	5	4	2	2	3	3	0	2	6	4	2	6
Neutral/None (N)	5	2	4	4	8	2	9	5	3	3	4	2
Antagonistic (A)	1	4	4	4	0	5	1	3	2	3	4	2
Overall Trend	S	S/A	A	A	S/N	A	N/A	N/A	S	S	A	S
Summary Over Time	**Positive to Neutral to Negative**				**Positive to Negative**				**Positive to Negative to Positive**			

[1] Anna experiences extreme positive and negative experiences associated with her plans to change departments making her interview difficult to rate overall. Therefore, her second year interview is excluded from the summary.

[2] Beth studies abroad in her third year and experience with faculty are not TPub faculty. Her third interview is not included in this summary.

[3]Julie leaves TPub at the end of her junior year to pursue a physics teaching degree and was not interviewed in her senior year.

G*enerally, students' feelings of autonomy*-support decrease after the first year. In the first year, most students view the faculty as supportive (five supportive (S) and one antagonistic (A)). In the second year they have split views with four students seeing the faculty as supportive and four reporting antagonistic behaviors. In the third and fourth years students are more negative with four students reporting more antagonistic behaviors each year and two reporting supporting behaviors.

Across all four years, students do not generally describe competence supporting behaviors by faculty. In the first year, only three students felt positively supported by faculty as freshmen although none described antagonistic behaviors. Student perceptions became sharply negative in the second year, with five students reporting antagonistic behaviors. In the third and fourth years, students describe more antagonistic behaviors than supporting behaviors but there are still many neutral ratings.

Students are generally positive about relatedness other than the third year where more antagonistic behaviors are described. Six students felt positively related to faculty in the first, second, and fourth years, but were somewhat more likely to report antagonistic behaviors in the third year. Over all four years, more women report positive relatedness than men, and men are much more likely to report neutral feelings or not discuss the topic.

In the following sections, exemplar quotes are given from the three variable categories.

Autonomy

Initially students describe autonomy supportive behaviors. In the second year they describe both supportive and antagonistic behaviors before describing predominantly antagonistic behaviors in the third and fourth years. Autonomy does not mean that students feel separate from others, rather they feel that their actions are self-motivated and that they are able to direct themselves [3]. Faculty members support student autonomy by providing resources and encouraging students to be self-motivated. Students that are unable to understand the flow of individual lectures, courses, or even program requirements would have their autonomy threatened. Another common complaint is about professors not providing the tools, e.g. working equipment and/or adequate instructions, which students need to succeed in their laboratory classes.

Freshman

Five freshman report the faculty are supportive of their autonomy, five freshmen are neutral, and one reports the faculty negatively impacts his autonomy. A common theme is that the faculty are receptive to feedback. One student had an instructor with a language barrier, but this professor was able to improve with student feedback:

> "…I think they give us evaluations like three times through like through the semester, so we'd try and give her…feedback on that and what, what's uh, what helped us understand better I think. So she, she kinda changed halfway through which wasn't a drastic change but it helped" (Mark, Freshman).

Another student said that the professors were gradually transitioning the students towards more autonomy, though it was not necessarily an easy process.

> "first semester like the study guides they gave you and whatnot were very similar to the tests. This one, they were more different so I guess I was kind of expecting them to be the same way and since they weren't, it kind of threw me for a loop. But you know, it's learning experience" (Joe, Freshman).

In the first year, students generally want more autonomy; they want to feel in control of their learning.

Sophomore

Only four of the eleven sophomores report that faculty members support their autonomy. Two sophomores are neutral; the remaining four report antagonistic behaviors. Behaviors that contributed to positive feelings of autonomy included grading practices. Students did appreciate the transparency in grading in their courses, and felt more in control because of that transparency:

> "Everybody calculates their grade come the end of the semester. Everybody knows exactly what they need on the final to keep an A or B in the class. It has to do with our twitchy math nature" (Marie, Sophomore).

Marie, like other students, appreciates feeling in control of her grades by knowing exactly how her grade is determined and how well she is doing on each required activity. As an example of faculty behaviors detracting from student feelings of autonomy, one student complains about the clarity of instructions:

> "One of the assignments that I got graded, he forgot to put some of the requirements on it. And, he didn't talk about. And so then, we all lost a bunch of points for not having those requirements" (Hillary, Sophomore).

Hillary was frustrated because she did not feel like she had all of the information she needed to do her work. Similarly, Beth complained about homework being about material that was not covered until after the homework was due, and so they had to turn to the internet to try to stumble through their homework assignments. Sophomores still wanted clear lectures with everything laid out for them even if the professor is teaching straight from the book, as one student emphasized:

> "…And he teaches pretty much straight out of the textbook, and the tests are like that too. But he just does a really bad job of putting notes up on the board and having them flow. So it's really kind of random, it doesn't really organize, have organization. I don't even take notes anymore…. because I can't get 'em to fit together right, so I can understand 'em" (Max, Sophomore).

Students like Max become frustrated when they believe the material is disorganized and not in a format they can use. One student summarized particularly well the sentiments of many students:

> "I mean, if the professor can logically explain the steps to getting through or whatever, then I'm very good at taking that explanation back and applying it to problems" (Joe, Sophomore).

Generally in their second year, students want information provided in a clear format that they can easily use and they want to feel in control of their grades. When this happens they feel supported and when it does not, they feel frustrated.

Junior and Senior

Overall students described more antagonistic behaviors in the third and fourth year. During the third year there was a lot of frustration about laboratory activities, and this frustration extends into the fourth year. In the third year, Anna's autonomy suffers because she believes she does not have the resources needed to complete the laboratory exercises,

> "I'd have to say labs here mainly my most negative experience. Not feeling like there's um, just almost giving up because you, you don't know what you're doing sometimes. But then there's no way you can find out because there's a lot, like textbooks don't explain that stuff to you. But, it's just the lab handout that isn't well-written" (Anna, Junior).

Similarly, in the fourth year, Beth is frustrated with equipment not working properly and having to spend her laboratory time fixing it:

> "I'm taking [specific class] this semester and, we had like tons of equipment that had major issues. And, our teacher doesn't really know what's going on. He's just kinda' like, "Oh, I don't know," like, "try and screw around with it. Fix it." And, we're like, "Great. That's wonderful." And like, it would be okay if then like you could write a report that was like, "Oh yeah, we were just like trying to fix our thing." And that would be okay. But, you can't, you still have to have like a report, written data, and like everything. You know? And, you're like, we just spent two hours fixing this thing. Now we get an hour to take all our data" (Beth, Senior).

Some students also feel less autonomous when their ideas of a reasonable workload conflict with what the professors are asking of them, especially when the requirement was not explicitly at the start of the project:

> "Senior design is kind of rough. Just the amount of work they expect you to put in outside of class. You know it's a three credit hour class so by the general rule it should be like nine hours outside of class and we get like a third of the way through the semester and our teacher's like, you know you guys should be doing like 20 to 25 hours outside of class. And we're like what?" (Hillary, Senior).

Hillary feels less in control of her progress when faced with an unexpected requirement to spend more time. At this point in their education, many of the students have developed a sense of

autonomy, i.e., what they need to do to succeed and are increasingly frustrated when they don't feel supported by the faculty. For example, Max has expectations for what a class should be and is disappointed when the class does not meet these expectations:

> "We just didn't learn anything, you know? The, just the level of, that class should have been so valuable to all of us. And, it was like, nothing" (Max, Senior)

Overall, students want more autonomy and want to feel in control of their learning.

Competence

Across all four years, students do not generally describe many competence supporting behaviors by faculty. Competence is the students' need to feel mastery of material and situations, which faculty members can support by recognizing student successes and inviting students to work with the professors on special projects. Although predominantly neutral in the first year, student perceptions became more sharply negative in the second year, with five students reporting antagonistic behaviors. In the third and fourth years, students describe more antagonistic behaviors than supporting behaviors. Students believed their competence was negatively challenged when faculty members refused to admit errors or made seemingly unreasonable course demands.

Freshman

During the freshman year, a common theme relating to competence was changing of mindsets from the high school environment where math and science students were handed the exact equations that they needed to the university environment that involved more exploration, theory, and challenging of ideas. While this was challenging for many students, it also offered opportunities for growth and was generally seen as supportive to developing competence. For example, in her freshman year, Hillary related how a professor encouraged her competence:

> "My professors all play devil's advocate so you can't just be like, "Well, I think this and the book says it too," they're like well, "Why do you think the book said that? Why was the author thinking that? Why do you think that?" and it's made me broaden my horizons a lot more I think" (Hillary, Freshman).

Hillary liked being challenged to think about content rather than just accepting it.

Sophomore

Five sophomores reported antagonistic behaviors towards their need for competence, with three students feeling the faculty were supportive. There were several instances of students perceiving professors unwilling to admit errors, which negatively impacted students' developing sense of mastery over their course material. One student was furious her sophomore year when a professor would not acknowledge that she was right about a problem with the homework.

> "So, I went in to him like, you know the numbers don't work, I'm positive I'm doing this right. I had the same formulas that everybody else got, you know exactly. And when I put my numbers in it just doesn't work. So he makes me derive the entire thing on the blackboard. And he goes, "No, no, no, this is wrong." I'm like, "No it's not." And so then I had to show him like why isn't wasn't wrong and he didn't really believe me. And like, somebody else finally came in, oh, it was picking me up to go to class or something, and like, he's like, "This is wrong isn't it?" And, I'm like, "No it's right." And so then like he's like, "Okay, leave it overnight." And he worked it out and got the same thing. And like the next day he finally believed me. So, like that kinda' made me kind of mad just because like, you know, "You don't, you don't believe me that I know what I'm doing?"" (Hillary, Sophomore).

Another student's confidence in her own ability was shaken by her a perceived lack of competence in her professor:

> "He would do example problems and then he would get confused. And, like, be like, 'Wait. No, no, we do this.' And then I would just get really confused and that just made me even more nervous for the test" (Leslie, Sophomore).

These two quotes demonstrate how students' negative perceptions of faculty actions detract from developing competence.

Junior and Senior

During the third year the students were again predominantly neutral in descriptions of faculty behaviors related to competence. In the fourth year, many students were still neutral although two students describe supportive behaviors and three describe predominantly negative behaviors. For example, despite having spent more than three years at TPub, Leslie still felt unable to approach her professor when she struggled in a course.

> "Some of the other teachers are just, here's the material, you should understand it. So you ask questions, you know like, I wouldn't even try to ask questions because I'd be afraid…" (Leslie, Senior).

While a fear of approaching faculty is also associated with a lack of feelings of relatedness, the perceived expectation that she is supposed to just understand what is presented is harmful to Leslie's sense of competence.

Relatedness

Students generally felt related to faculty other than during the third year. Relatedness behaviors included faculty members having open doors and encouraging students to stop by, engaging them in meaningful conversation. The only observed gender difference in responses was seen with regard to relatedness. Throughout the years, more women report positive relatedness than men do. Men are much more likely to report neutral feelings or not discuss the topic.

Freshman

Six freshman reported positive relatedness, three were neutral, and two were negative. Several students reported professors' open-door policies and eagerness to speak with them. Still, there was still some trepidation. For example, Leslie was simultaneously intimidated by talking to a department head yet happy about the interaction:

> "I went and talked to the head of the [specific department] and just got her perspective like, what the [areas] are and like, just what are some of the classes I can take to see if I really would like to do it so that was kind of intimidating for me cause she's really well respected and everything but it was also good" (Leslie, Freshman).

As an example of negative feelings of relatedness, Tim did not want to speak to the professors when he needed help because he did not regularly attend class and therefore thought he would be wasting the professors' time by asking for help.

> "Any question I ask him, he's gonna be thinking, "Well why wasn't this kid in class? I taught this in class, and he's not there, why should I tell him again." So I mean definitely some, some profe-, some professors are harder to talk to, but that, that was my own fault. For the most part though, all the professors have made themselves accessible, which is a good thing" (Tim, Freshman).

In this case, Tim takes some ownership of finding professors difficult to talk to. He believes that if he attended class more often, faculty would be more willing to talk to him.

Sophomore

During the sophomore year, four students described positive relatedness while three were neutral and three described negative behaviors. As an example of positive behaviors, one sophomore appreciated her professor learning everyone's names and relating organic chemistry to real life, thereby fulfilling her need for relatedness.

> "I think, after the first test, he had everybody, like our class of a hundred plus kids, he knew everybody's name. And, that was really cool. And then, like, I think it's really interesting, just it's what happens like it explains everything so much of what we do in daily life is organic chemistry, so that's really neat" (Hillary, Sophomore).

Students feel connected to faculty when the faculty are engaging in class. Joe describes with admiration a professor who strives to connect course content to real-world applications:

> "We're talking about this one kind of metal one day, he brought in a part from like an airplane that he worked on. It's like, and this is why you need to make this metal. This is the special characteristics. And, it really tied things together" (Joe, Sophomore).

As an example of negative behaviors, Marie felt that students had to compete for attention, and that only the best students would be noticed:

> "And the kids with the highest scores are the ones that get the attention from the professor. And so accordingly will get thought of in terms of positions available" (Marie, Sophomore).

Overall, in contrast to the availability of the freshman professors, many of the sophomores report not being able to access their professors as demonstrated through the following three quotes:

> "She is so busy and has so much on her plate that she doesn't even really have time for me." (Max, Sophomore)

> "He manages by crisis too - Or so I'm told. He's pretty high up there in the [specific department] department. He teaches several classes. And then also has like research and in department projects like the [specific project] And – so he's hard to hunt down. And I don't have the time to just sit outside of his office patiently. I just stop by 3 or 4 times a week and am always like, 'yep, still not here'" (Marie, Sophomore).

> "I try to talk to my advisor. He said, "Go talk to your peers." "Okay, thank you sir"" (Tim, Sophomore).

Perceptions of faculty availability strongly contributed to negative feelings of relatedness.

Junior

In contrast to the other three years, juniors generally describe negative behaviors regarding relatedness with only two students described positive relatedness actions and four students describing negative behaviors. Positive feelings of relatedness remain associated with faculty who bring in the real world to the course material:

> "He's just very interesting. He tells stories about the real world. He talked to us about grad school. He didn't have to, but his notes are cool and he, he brings a real world view to it. And, he um, he writes down his notes. Yeah, they're in circles, but, um, and his tests and quizzes are hard, but we have a quiz like every other week. And so, it makes you study the stuff" (Anna, Junior).

Perceptions of faculty being unavailable are still associated with negative feelings of relatedness and students are frustrated by their professors' distance from the students and prioritization of research over teaching. One student, when asked what suggestions she had for the faculty, responded:

> "Teach professors to at least fake that they enjoy teaching the classes I think a lot of my classes the professors seem completely uninterested in what they're doing. They've done it X number of times, and they have to do it six more times today" (Marie, Junior).

Senior

The senior year is much more positive than the previous two years. Six students describe positive relatedness behaviors and only two describe predominantly negative behaviors. As examples of positive behaviors, Joe appreciates smaller classes and when faculty are passionate about what they are teaching and Mark reflects on relationships with faculty over time:

> "When the professors are teaching in their expertise and you can tell they're really passionate about what they're teaching. They're smaller classes, smaller labs. It's, it's really nice" (Joe, Senior).

> "I've gotten quite a bit of attention from, from certain professors that you kinda' grow with, and you come back for advice, for with. And, I mean if you go to the office, as long as you seek someone out, you'll get personal attention" (Mark, Senior).

However, some students like Marie find that faculty are available to but not engaged with students:

> "I guess just at the end of the day, like if you come in and you have a question they'll answer your question. But, they don't really seem like concerned about whether or not you get it right later. Or, I just kind of feel like they're not interested in getting to know you as a person at all. And, I don't know, I, I guess that would be unreasonable to expect, but, but yeah, they're very available otherwise" (Marie, Senior).

The senior year interviews generally show a greater sense of reflection over the previous years. Many students have had internships which changes their perspective on classroom experiences and being on campus for four years students have had more time to develop relationships with faculty.

Discussion

By examining the student perspective, this research provides further insight into the role faculty play in student engagement in learning during undergraduate careers. Framed in self-determination theory (SDT), results show students initially describe faculty behaviors as positively contributing to student's autonomy, competence, and relatedness beliefs although they become neutral or negative at various points in time. A primary implication for practice is the need for faculty, across all four years, to consider the potential impact of their behaviors as negatively contributing to student motivation.

The key overall findings of this research are:

- Generally, students' feelings of autonomy-support decrease after the first year.
- Across all four years, students do not generally describe competence supporting behaviors by faculty.
- Students are generally positive about relatedness other than the third year where more antagonistic behaviors are described.

A secondary finding, and the only gender difference, is that over all four years, more women report positive relatedness than men, and men are much more likely to report neutral feelings or not discuss the topic.

All of these findings suggest gaps between our current classroom practices and students' needs for autonomy, competence and relatedness. With regard to autonomy, students do not feel supported. They do not feel in control of their own learning or have the clarity instructions, functioning laboratory equipment, etc. that they need to successfully complete assignments and learn the content. With regard to competence, across all four years students are not feeling supported by faculty in their efforts for competence and mastery. We know from recent research that competence related constructs, including self-efficacy, are important to students', and particularly women students', success. [26-31] The news for faculty is better with regard to relatedness. Other than the third year, students do describe faculty behaviors that contribute to feelings of relatedness. Further work is needed to understand what happens in the third year where faculty are perceived negatively with regard to relatedness. Possible explanations could lie in anecdotal reports from students that the third year is the busiest and hardest or considering that autonomy and competence beliefs are also low in the third year.

The primary implication is that faculty need to be more aware of their actions and how such may perceive such actions. While many of the negatively perceived behaviors described by students could have many possible positive explanations from the faculty perspective, what matters to student motivation is the student perception. Reality is less important than perception. While we cannot possibly determine how students will interpret our every action, we can glean from this research that simple actions could make a difference. For example, being sure instructions on assignments are clear and being sure equipment students are asked to use is in working order could alleviate student frustrations. We can also take away the message that we need to be more encouraging of students in their quest for mastery. We need to help them feel competent.

This research sets the stage for future research. This current research is limited in the fact that students were not directly asked about their autonomy, competence and relatedness beliefs. Nor were they directly asked how faculty impact these. However, by examining what emerged from interview conversations about students' general experiences learning engineering, this research points to the importance of these constructs. Future work should look more directly at the autonomy, competence and relatedness beliefs, how these beliefs develop and change with time and specifically how faculty can more positively contribute to such beliefs.

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Appendix

Rankings for Each Participant

	Autonomy S = Supportive Behaviors, N = Neutral/None, A = Antagonistic Behaviors				**Competence** S = Supportive Behaviors, N= Neutral/None, A = Antagonistic Behaviors				**Relatedness** S = Supportive Behaviors, N = Neutral/None, A = Antagonistic Behaviors			
	Year				Year				Year			
Participants	1	2	3	4	1	2	3	4	1	2	3	4
Max	S	A	A	A	S	A	N	A	S	A	N	N
Mark	S	S	A	N	S	S	N	N	N	N	A	S
Will	N	S	N	N	N	S	N	N	N	S	N	N
Tim	A	N	N	A	N	N	N	N	A	N	A	A
Joe	S	A	A	S	N	A	N	N	S	N	N	S
Anna	N	S/A[1]	A	A	N	S/A[1]	N	S	S	S/A[1]	A	S
Hillary	S	S	S	N	S	A	N	S	S	S	S	S
Beth[2]	N	S	-	N	N	S	-	N	N	S	-	S
Marie	S	A	S	A	N	A	N	A	S	A	A	A
Leslie	N	A	N	A	N	A	A	A	S	S	S	S
Julie[3]	N	N	N	-	N	N	N	-	A	A	N	-

[1] At the end of her second year, Anna is preparing to change departments. She is generally very negative about the department she is leaving and very positive about the one she is joining. This experience dominates the interview and results in extremes in positive and negative experiences.

[2] Beth studies abroad in her third year and so the faculty she discusses in her interview are not TPub faculty.

[3]Julie leaves TPub at the end of her junior year to pursue a physics teaching degree.