# Investigating How Engineering Faculty's Perceptions of Students are Influenced by Experience Level

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## Abstract

In an academic world undergoing continuous transformation, understanding faculty viewpoints is essential for fostering resilient and adaptable education systems that cater to the ever-changing needs of students. Faculty members are central to shaping students' learning experiences, making their perspectives a foundational element in supporting the dynamics between students and educators. Faculty not only guide pedagogical strategies but also significantly influence students' preparedness to tackle future challenges. Developing faculty members as adaptable and attentive instructors is important because they directly impact student success and the quality of education delivered. This study is an exploratory qualitative study that utilizes thematic analysis to identify commonalities within the semi-structured interviews of six faculty members who teach first- and second-year engineering courses at a large, public, land-grand university in the Midwest. This study initially aimed to examine faculty members' perceptions of their students before and after the pandemic; however, a more in-depth analysis of the data unexpectedly unveiled insights hinting at the potential role of faculty experience levels in shaping these perceptions. Accordingly, this paper addresses the following research question: How are faculty perceptions of their undergraduate students before, during, and after the COVID-19 pandemic impacted by their experience level? This paper highlights the pivotal role of experience in shaping faculty perceptions, subsequently impacting the strategies employed to prepare students for the dynamic landscape of education. As a contribution to the ongoing discussion on adapting engineering education in the wake of disruptions like the pandemic, this paper provides valuable insights for faculty development amidst evolving educational contexts. It also advocates for a deeper exploration of how faculty experience influences these perceptions, ultimately promoting a dynamic approach to teaching within the educational environment. Lastly, this study lays the groundwork for future research investigating the intersection between faculty adaptability and the ever-changing needs of students over time.


## Introduction and Literature Review

The perceptions that faculty have about their students can impact how they approach their teaching [1]. Faculty beliefs are known to guide their instructional decisions [2] and influence their classroom practices [3]. However, while some faculty's classroom practices are consistent with their beliefs about teaching and learning, other faculty's practices have been shown to be inconsistent [1], [3]. For example, Ross et al. (2017) found that even when professors were actively engaged in learning about student-centered teaching, they did not implement those techniques into their courses [1], while Moore et al. (2015) found that using model-eliciting activities helped faculty shift their beliefs towards student-centered teaching [2]. Altogether, these studies demonstrate the importance that faculty beliefs play in determining their instructional practices and in creating equitable educational experiences for students.

While faculty beliefs can have a large impact on their teaching practices, few studies have examined faculty perceptions of student readiness for engineering and few studies have explored the ways in which faculty perceptions vary by experience level. Faculty perceptions have been

explored with respect to other aspects of engineering students, including student engagement [4], [5], student creativity [6], and student knowledge [7]. Understanding faculty perceptions of student readiness is critical because faculty are central to shaping learning experiences. Moreover, in this post-pandemic world where today's college students were in high school when COVID interrupted education worldwide [8], understanding faculty perceptions of student readiness is more important than ever. Significant achievement gaps still exist, with Lewis & Kuhfeld (2023) finding that students need approximately 4 additional months of schooling to catch up in reading and math [9].

This study's inquiry into faculty perceptions of student readiness for engineering grows out of a pilot study that was initially designed to understand how the disrupted pandemic years of learning in high school impacted students' readiness for college-level engineering work. To answer this question, we opted for faculty perspectives of student readiness, as student self-perceptions are limited by the Dunning-Kruger effect [10], and standardized measurements (like the ACT and SAT) were largely suspended during the pandemic years. Faculty who had experience teaching prior to the pandemic could be well-positioned to notice changes in student readiness. However, in pursuit of this question about the impact of the pandemic on students' readiness for engineering, we discovered that engineering faculty had different perceptions – and different opinions of their own perceptions – based on experience level. This paper explores this phenomenon, addressing the following research question: How are faculty perceptions of their undergraduate students before, during, and after the COVID-19 pandemic impacted by their experience level?

## Methods

We used an exploratory qualitative approach to answer this research question. In this study, we implemented semi-structured interviews with six faculty members who teach required courses in the first two years of the engineering curriculum at a large, public, land-grant, research-intensive university in the mid-west. Participants were required to have experience teaching at least one semester before Spring 2020. Note that to avoid making participants potentially identifiable, we withhold demographic information and use "they/them" pronouns. Each faculty member was interviewed once, and interviews took place in Fall 2022 and Spring 2023. At the time of interviews, the university no longer had any COVID-restrictions. The timing of the interviews meant that students who had been juniors in Spring 2020 (first pandemic semester) would be sophomores in Fall 2022. Accordingly, we scoped our investigation to first- and second-year courses. At the time, these were the only courses that students who experienced the pandemic for more than a semester during high school would have been taking.

The interviews were semi-structured and lasted approximately 45 minutes. All interviews were conducted via Zoom or in person and were transcribed by a professional transcription service. The interviews were aimed at uncovering differences that faculty had noticed in their courses since the COVID-19 pandemic began. Interview questions (Table 1) were developed by the research team and were piloted for clarity. Participants were sent the interview questions prior to the interview to allow them to gather class data and reflect on the differences beforehand.

**Table 1. Semi-Structured Interview Questions**

| High-Level Interview Protocol |
|---|
| 1. What differences have you noticed in teaching before, during, and after COVID? |
| 2. Before COVID, did you notice any gaps in students' readiness for your course? |
| 3. Since COVID, have you noticed any changes in students' readiness for your course? |
| 4. Since COVID, have you noticed any changes in student performance? |
| 5. Are there concepts that you are finding your students are not coming in ready for? |
| 6. Have you made any changes to your course as a result of COVID? |
| 7. Have you noticed any changes in office hour attendance? |
| 8. Is there anything else that we should talk about that we haven't talked about so far? |

Interview data were analyzed using an iterative coding process. First, Author 1 identified themes within and across the interviews about the impact of the pandemic on student readiness. This first round of analysis revealed that faculty members' perceptions and opinions of their perceptions varied based on experience level. After discussions between Author 1 and Author 2, the second round of coding then explored this question, dividing faculty into groups based on experience level and describing their perceptions and opinions within each level.

*Positionality of Authors*

As a third-year undergraduate student studying mechanical engineering, Author 1 has experienced the educational disruptions caused by the COVID-19 pandemic. At the onset of the pandemic, Author 1 was in high school and entering the third quarter of her junior year. Following spring break, all of her classes transitioned to online delivery for the remainder of the school year, followed by optional in-person attendance during her senior year. Subsequently, Author 1 observed significant changes in instructional methodologies and course structures, resulting in a noticeable decline in both her classmates' and her own comprehension and depth of understanding of the course material.

Author 3, an Assistant Professor of Mechanical & Materials Engineering holding a PhD in engineering education, was completing her doctoral studies when the pandemic began. This circumstance prompted her to redirect her dissertation research to investigate the ramifications of COVID-19 on student experiences at an international level. Motivated by these experiences, Author 1 was driven to explore the impact of the pandemic on students transitioning from high school to engineering programs—a traditionally difficult transition. To shed light on the challenges faced by these students, Author 1 proposed the initial framework for this project to Author 3, who contributed to the comprehensive conceptualization of this exploratory study.

Author 2 joined the team after most data analysis was completed and helped write the findings section of the paper. Author 2 is a civil engineering undergraduate student and an undergraduate researcher working under Author 3. All authors identify as white women.

## Findings

After conducting a thematic analysis on the data, we observed recurring themes that were prevalent among professors with comparable levels of experience. As a result, our findings are structured according to the experience levels of the participants. Table 2 defines these experience levels and the corresponding professors that fall under each category. Note that Level I correlates to the assistant-level, Level II correlates to associate/full-level, and Level II correlates to the full-level. Participants spanned different types of roles, including tenure/tenure-track and professor of practice (i.e., teaching-track). We also structured the limits of each level based on how the data within each potential level compared.

**Table 2. Participant's Level of Experience**

| | Level I | Level II | Level III |
|---|---|---|---|
| **Years of Experience** (as an engineering professor) | ≤ 6 | 7 – 30 | ≥ 30 |
| **Professor(s)** | B | A, D, E, & F | C |

### *Level I – Have the students changed, or have I?*

Professor B was the only professor with less than or equal to six years of experience as an engineering professor. Professor B was initially hesitant to participate in this study, as they felt their lack of experience would hinder their ability to acknowledge differences in their students pre- and post-pandemic. They said:

> When COVID hit, I was only in my third semester teaching [second-year Mechanical Engineering course] … I was still learning and trying to optimize my class. For some of the changes [in students] I have noticed over the years, I would be tempted to attribute them mostly to my changes in teaching style and ability.

Professor B was hesitant to attribute changes that they noticed in students to the pandemic, noting the extensive changes and improvements that Professor B had made to their teaching since they began. Although Professor B did not report any qualitative differences in student ability, we asked them if they made any changes to their course since the pandemic. During the pandemic, Professor B started having their students submit their assignments (homework and weekly quizzes) online via a PDF submission. By making this change, students could keep the physical copy of their assignments to ease future studying. In addition, having digital copies of the assignments eased grading and made organization easier.

### *Level II – Noting Specific Skills*

Professors A, D, E, and F have been engineering professors for anywhere between seven and thirty years. In contrast to Professor B at Level I, participants in Level II noted several areas where they saw post-pandemic students struggle. These areas are organized into themes and presented in order based on how many interviews each theme appeared in.

*Problem-Solving and Math Skills*

All professors in Level II mentioned a decrease in students' general problem-solving skills. Professors E and F specifically noted that their students' ability to problem solve – that is, to see an example in class and solve a similar problem on the exam – had decreased. Professor F said:

> The way that I taught my course is by using a lot of problem solving during the class. So, I introduce the concept, and we do a lot of examples. And anything that will be on the test will be, in some form, an example that we discussed during class. And I was surprised to see that a lot of students could not capture this. I mean, they could not see it and apply that in the test. That was a surprise for me, and I don't know, I have no explanation why they couldn't do it, because I particularly also pointed out what was important for the problem and why we have to solve it this way.

Professor A and D also highlighted their students' struggle with manipulating and applying formulas in course-related contexts. Professor A said their students were struggling with their ability "to translate a word problem, to selecting a correct formula, to then actually execute that formula."

In addition to facing new challenges with problem solving, Professors A and D noted a decrease in students' general math skills, specifically their trigonometry and algebra skills. Professor D said:

> I think there are more students struggling with basic math concepts. But I feel that [my course] is an engineering course, not a math course. So, I don't pay too much attention to it. And I probably should—I know that my colleague, who teaches my course when I don't teach it, spends lots of time introducing basic math concepts. But as a result, [they] cover way fewer topics than I do. This is the trade off—and I always feel that I take for granted something that I shouldn't, but I assume that if they pass some basic calculus or algebra, then they should have all of the skills already.

This excerpt emphasizes the challenge of addressing student knowledge gaps: if the missing skill is perceived by the professor as a skill the student should already know, they may not take (or have) the time to re-teach those skills. Professor E also mentioned a decrease in their students' math skills but did not attribute the decrease to the pandemic.

*Social Skills, Asking for Help, and Engagement*

Professors D, E, and F explicitly mentioned a decrease in their students' social skills or maturity. Professor D said:

> Clearly, they are lacking lots of social skills after the pandemic. So last year, during the entire semester, nobody came to my office hours in Spring 2022. Not a single person, not even once, for the entire semester... before the pandemic, I would have 20 students a week.

Professor E said their students are lacking in 'common sense' and there has been a drastic increase in student excuses. Professor E also mentioned that students' seriousness about assignments has decreased, and students' sense of teamwork has weakened. Professor F mentioned their students are not advocating for themselves (or their grade) as much as previous

cohorts of students have. They mentioned, “I would always have a pileup of students in my office after tests before COVID. And they would all negotiate with me how, why I would have deducted points... after COVID, they didn't even pick up their exams, or try to negotiate it.” In addition, Professor F feels their students have a decreased ability to utilize resources, ask for help, and has seen an increase in exam accommodations.

All professors in Level II noticed a decrease in student attendance of some capacity. Professors A, D, and F noticed a decrease in office hour attendance, and Professors A, E, and F noticed a decrease in overall class attendance. In addition, Professors A and E specifically mentioned a decrease in student engagement and preparedness for in-class teaching. Both professors suggested that this decrease in engagement may be related to the Zoom classes where students could passively attend class.

Conversely, Professor E found that their office hour attendance increased as a result of the addition of a Zoom option. Since their students do not have to be physically present for office hours, they found many more students were logging on to ask questions. They noted that their commuter students who live far away from campus are unlikely to make the trip to ask a couple of questions. Zoom office hours have been a positive impact for Professor E’s attendance.

> Before COVID..., I have office hour[s], but I rarely see them come in... During COVID, my office hours completely moved to Zoom, and I can see [more] students. After COVID, even though we meet in-person... I still make it a Zoom, and the students sometimes jump in... They know there is a path when the in-person meeting is not available.

*Changes Made*

We asked the professors to identify any changes they have made in their courses since COVID. Professor A and E both described decreasing the speed of content delivery. Both professors noted that their students struggled to keep pace with their typical course, so slower instruction was necessary. In addition, Professor A noted that they significantly increased their depth of explanations in their course, as they noticed thoroughly explaining their thought processes to their students improved their learning.

Next, Professors E and F explained the benefits they gained from being forced to adapt to online teaching during the pandemic. Both professors claimed they have integrated more online tools (e.g., Zoom, lecture recordings) to their course, which have been beneficial to their students. Professor F explained how “COVID made it possible for [them] to explore something, and that was online teaching, and I do find [it to be] a helpful tool.” Moreover, Professor E attributed their *increase* in office hour attendance to their integration of Zoom office hours, which enabled more students to access office hours.

Finally, a change made by Professor B (of Level I) was also made by Professor E, which is PDF assignment submissions. Similar to Professor B, Professor E found the online submissions to be helpful to both instructors and students beyond the pandemic.

### *Level III – A Wide Lens*

Professor C was the only participant with more than thirty years of experience as an engineering professor. When asked about noticeable differences observed during their tenure, they claimed that the changes "are not big." Among the few changes highlighted, they initially mentioned the gradual shift in technology.

> When I started, we were still using card punches […] By the time I came [to their current university], we had gotten rid of card punches, and we were starting to have little PCs showing up… so you can see the transition. Now, your cell phone is more powerful than any computer we had at the time. […] So, it's always been a gradual thing.

Throughout their career, the standards of technology have changed drastically. However, as technology continues to evolve rapidly, Professor C shared that, generally, their students, at a group level, enter each semester with similar levels of knowledge.

> It's never been that the group hasn't had [the skill]. I have always had [some students] who have somehow gotten through the [education] system without that particular [piece of] knowledge; and this has always been the case.

Moreover, when asked to specifically pinpoint gaps in readiness for their course during the years surrounding the pandemic, Professor C confirmed that they have not noticed significant changes among the students. Professor C emphasized that education demands adaptability and attentiveness to student needs.

> The thing is—if I [work through] it at the beginning, it's no problem. If I put a problem with maximization, minimization, and I put a problem with triangles, and I've done this and that, I don't see any problems. So, I don't think having [gaps in readiness] an inherent weakness. But I have always had to be aware—this is over forty years; I've never been able to simply let the students go and expect things to work out. I have to say, 'Okay, I have to do this because this will make them ready. Okay, even though they have this knowledge, they've forgotten some of it and that's the problem.' […] Whatever you do, education is not going to be the same every time. Even if you have three or four sections of [the same course], you can't follow exactly the same steps. There will be little things left out of one, but not the other.

However, Professor C shared one exception to their typical teaching experiences following the onset of the pandemic: "COVID did alter [that trend] a bit. I remember Spring 2022, where for the first time in my life, I thought 'I can't do this, there is something wrong.' But [that feeling] hasn't lasted."

Although there was one semester that deviated from Professor C's usual experience, they stated that "last spring, [they] had a feeling, but that feeling went away. [Knowing that] is essentially telling [them] that [they] can't trust that particular semester; [such semesters] happen occasionally, and COVID would impact much more than one semester."

Due to extensive teaching experience, Professor C acknowledged that engineering education will always fluctuate, resulting in anticipated highs and lows with changing times. Despite their

frustrations with one semester post-COVID, they still believe that COVID is just another component of the traditional fluctuations in education.

However, despite their broad perspective and minimal noted changes, one adjustment that Professor C made to their course as a result of COVID was the incorporation of study groups into their course structure. In their course, study groups contribute to a percentage of the students' grades and entail meetings with their assigned team and teaching assistant. This concept arose from student complaints about a lack of interaction during distance delivery in the midst of the pandemic. The introduction of study groups prevented student isolation, enhanced interaction between students and teaching assistants, and was generally well-received. Due to its positive impact, Professor C decided to retain study groups in their course beyond the lockdown.

## Discussion and Conclusion

The goal of this study was to explore how faculty perceptions of changes in their undergraduate students during the pandemic are impacted by their experience level. We found that the Level I professor who was relatively new to teaching and who valued improving their teaching was hesitant to ascribe any changes in student performance to the pandemic. On the other hand, Level II professors noted the most changes in students, while the Level III professor more holistically discussed changes in students across their career.

### *Perceptions and Epistemology*

The apparent differences present across the groups of professors with different experience levels suggests that faculty perceptions of their students change over time. The professors that had been teaching for 6-30 years were able to identify differences in their students; whereas the professor that just began and professor who had been teaching for 40 years were not able to identify differences. The young professor was unable to identify which changes were due to their students experiencing the pandemic or them changing their course. On the other hand, the professor who had been teaching for 40 years seemed to have such a wide lens of teaching experience that they were unable to point out changes that resulted from the pandemic.

While this difference in perception aligns with experience level, it may also speak to an underlying epistemological difference between traditional engineering disciplines and the discipline of engineering education research. Engineering professors typically come from a positivist or post-positivist paradigm, which prizes objectivity and sees the observer as separate from the observed. Engineering professors may also approach research from an experimental perspective, wherein all extraneous variables must be controlled and wherein the goal is to definitively attribute an effect to its cause. So, when interviewed for this study, it is understandable that some professors were hesitant to note changes that they did not feel they could definitively attribute to a single cause (i.e., the pandemic). We found that participants often discounted their own perspectives because they did not view them as objective.

*Student Mental Health*

Student mental health experiences may be impacting the perceived changes, specifically with respect to their social skills and engagement in class. The pandemic allowed students to learn at home, behind a screen for two years and in-person interactions with teachers were nearly impossible at that time. Moreover, it is common to have to teach students how to ask for help, attend office hours, and advocate for themselves, especially for students who are first-generation. Students may not know that they can or should advocate for themselves and attend office hours. Alternatively, students' mental health may be playing a role in their lack of attendance or engagement. Future work should examine these trends to understand and address the underlying causes.

*Skills Interventions*

Several professors noted having to change their instruction style, either slowing down or adding more detailed explanations, and they noted that students still struggled to see the alignment between examples in class and problems on the exams. This finding may indicate a need to more explicitly teach problem solving techniques, so students are more able to make the connections between what they see in class and what they learn on the exam. Moreover, professors noted that students faced challenges with certain areas of math, like trigonometry and algebra. This finding may indicate that students will need to review or (re)learn pre-requisite math. We encourage professors to utilize "pre-test" assessment techniques to determine whether students have the pre-requisite knowledge for the course. Professors can provide resources for reviewing weak areas so that students can get up to speed for the class. Universities may also need to implement stricter and more secure testing procedures when deciding whether students' math courses should transfer. Students may be missing key trigonometry, algebra, or calculus concepts and may need to take a remedial course first before progressing through the program. Moreover, many universities utilize summer bridge programs, which aim to improve student readiness for first-year engineering courses [11]. Universities may need to build upon this existing infrastructure to reach more students, as challenges with readiness are likely more widespread than before the pandemic.

*Adaptability (or a lack thereof)*

Embedded in the findings are professors' beliefs about adaptability – that is, whether they should adapt to the needs of the students. We saw that, while some professors did adapt their practices because of the pandemic and kept those adaptations post-pandemic, others avoided making changes, expecting things to go back to "normal" eventually. Being a good teacher, especially as a lifetime career, requires professors to be adaptive and in tune with both their students' and the engineering industry's ever-changing needs. COVID was just one interruption and there will continue to be more disruptions and generational changes in the future—especially with how fast technology is evolving. Future work can focus on training professors to be adaptable and constantly evolve their teaching practice to meet the needs of their students. We encourage professors to use mid-semester evaluations and reflection assignments to learn the needs of that cohort of students and adapt accordingly.

## Future Work

Pandemic-related learning disruptions will continue to cascade through the educational system for the next two decades as grade-school aged students' progress towards college. Additionally, faculty perceptions will continue to influence how faculty teach. Future work can explore these discussion implications more in depth, seeking to understand 1) how epistemology impacts engineering faculty engagement in engineering education research, 2) how student mental health impacts their help-seeking behaviors in courses, 3) how to improve pandemic-induced gaps in math readiness and problem-solving skills, and 4) how to foster and improve faculty adaptability.

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