

International engineering students' resistance to isolating university experiences: An opportunity for greater inclusion in engineering education

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Abstract: In recent years, large numbers of international students are attending engineering schools in the US; however, more could be done by the schools to support the unique challenges these students face. This study analyzes five semi-structured interviews with international electrical and computer engineering students at Purdue University to identify the unique challenges they face due to their international status, how they persist despite the challenges, and what engineering schools can do to better support them and all students given these findings. Using a framework of student resistance, the theoretical thematic analysis found that international engineering students can struggle with language barriers and social isolation, and that these challenges are often made invisible in the environment of the school. These students most commonly persist by adapting or conforming to the domestic environment, either individually or collectively; they exhibit very few instances of resistance by our chosen definition. To better support international students, we recommend that engineering schools implement more active learning, collaborative learning, and multicultural and group communication education. These initiatives would also improve the experiences and education of all students, including underrepresented students. This article contributes to discussions about the definition and usage of student resistance as a framework for education research.

Introduction

The numbers of international students attending US institutions have increased drastically over the past several decades for multiple reasons: the students are motivated by the quality and reputation of the schools and job opportunities in the US, and the schools are interested in international students as quality future workers to the country and because international students often pay high tuition that many domestic students are unable to pay [1]. International students are important to the US economically and for the development of an increasingly globalized world, in which it is vital for students of higher education to be able to understand and collaborate with others of different cultures [2]. Because of these benefits to schools and the country, many US institutions work actively to attract more international students. However, once these students arrive at the schools, they often struggle with adjusting to a new culture and/or language, feelings of isolation, and difficulty working with domestic students [3]. These struggles show that more could be done by engineering schools to support international students' sense of inclusion, which in turn would support their ability to learn. This study aims to identify challenges that international students face in the US and possible initiatives that would improve their learning and educational experience. In turn, we believe these same initiatives would benefit all students, including other types of underrepresented students.

This study is part of a larger NSF-funded project that investigates the intersections of diversity and inclusion, socio-technical perceptions of engineering, and the professional formation of engineers. It is an analysis of five interviews with senior undergraduate international students in

the electrical and computer engineering (ECE) program at Purdue University. This particular engineering program has a high population of international students compared to other programs in the university. We analyzed the interviews with the framework of student resistance, which is defined as oppositional behavior by students that recognizes and attempts to change systems of oppression [4]. We conducted a thematic analysis on the interview transcripts to identify instances of exclusion – ways that students felt unsupported or isolated in school – and persistence – strategies students used to continue despite exclusion – of these international students in the course of completing their engineering program. We investigated the following research questions:

RQ1: How does international status uniquely affect the engineering student experience?

RQ2: How do international students persist in engineering programs built for domestic students?

RQ3: How can engineering schools better support international and all students based on this information?

Instances of exclusion that particularly affected international students included the language barrier and social isolation. International students' persistence strategies mainly consisted of various ways students adapted or conformed themselves to the domestic environment, either alone or with the help of others. In the conclusion, we use our results to make recommendations for initiatives to improve the international student experience. These include more active learning, collaborative learning, and multicultural and group communication education for all students.

Theoretical framework

The theoretical framework used for this analysis is student resistance. "Resistance" in an educational context has been defined in varying ways, so we first provide some background on the concept according to different scholars across time, before giving a rationale for the definition we used.

In his book *Theory and Resistance in Education*, Henry Giroux used "resistance" to describe a certain type of oppositional behavior by students which was born out of "moral and political indignation" [4]. Looking at students' oppositional behavior through the lens of resistance, he argued, highlights the dynamic nature of struggles of power within schools, so that "the oppressed are not viewed as being simply passive in the face of domination." Power is not exercised only in one direction, by the powerful onto the powerless, but acts of resistance are in fact also exercising their own form of power. To be labeled resistance, he argued, an oppositional behavior must be rooted in a "critique of domination" and a "struggle for emancipation." In other words, in enacting resistance, a student both recognizes systems of oppression and acts to change them in the future; as Giroux wrote, "inherent in a radical notion of resistance is an expressed hope, an element of transcendence, for radical transformation." By this definition, identifying resistance is not straightforward because whether a behavior is resistance depends on the intentions of the person acting and on the cultural and historical context from which the behavior

emerged. Additionally, Giroux's definition stresses that not all oppositional behaviors are resistance, and that accommodating or conforming behaviors are not resistance.

Solorzano & Delgado Bernal used Giroux's two criteria for resistance (critique of domination and struggle for emancipation), which they called "critique of social oppression" and "motivation for social justice," as axes of a new taxonomy of student resistance that defined four categories of behaviors based on which of the two criteria were present [5]. They labeled a behavior with both criteria "transformative resistance" – this is Giroux's resistance. However, they also called a behavior resistance if it had only one of the criteria; with only critique of social oppression, they labeled it "self-defeating resistance," and with only motivation for social justice they labeled it "conformist resistance." With neither criterion, they labeled it non-resistant "reactionary behavior." They also described two types of transformational resistance: internal and external. Internal transformational resistance can appear outwardly conformist even though the student is actually intending to make change, whereas external transformational resistance does not conform to norms and expectations. Therefore, they agree with Giroux that identifying resistance depends on knowing the student's intentions and context.

Tara Yosso expanded on the concept of student resistance by arguing that resistance is a form of capital – "resistant capital" – that marginalized students use to persist [6]. She defined resistance as "oppositional behavior that challenges inequality," and resistant capital as "those knowledges and skills fostered through" resistance. However, she also cited and agreed with Solorzano & Delgado Bernal that self-defeating and conformist behavior could be forms of "resistance."

In this paper, we use Giroux's strict definition of resistance as oppositional behavior rooted in both social critique and a struggle for change. Thus, we do not include self-defeating or conformist behavior in the category of resistance, and we acknowledge that understanding of the student's intentions and context is needed to claim their behavior is resistance. Our exclusion of other oppositional behaviors from the label of resistance is not intended to diminish their importance, as all oppositional behavior is worthy of investigation in order to improve education. However, using the strictest definition of resistance maintains the concept's usefulness as a research tool.

Methods

This qualitative study is based on a constructivist research philosophy, which attempts to describe participants' experiences from their unique points of view [7]. The context was the electrical and computer engineering (ECE) department at Purdue University, a large US research university. This department has a high population of international students compared to other departments in Purdue's engineering school; as of Fall 2021, 26.4% of ECE undergraduates were international students, while 14.4% of all engineering undergraduates were international students [8]. Interviews were collected through convenience sampling [9]; an undergraduate research assistant solicited and conducted interviews among their classmates. Five interviews were collected with seniors in the ECE program who were international students. Two students were from Taiwan, and the other students were from Nigeria, Ghana, and India, respectively (Table 1). The semi-structured interviews included questions about students' backgrounds and why they chose to attend the university, what it means to be an (ECE) engineer, their experience in the program, school culture, diversity and inclusion, and their sense of belonging in the program.

Pseudonym	Nationality
Student 1	Taiwan
Student 2	Taiwan
Student 3	Nigeria
Student 4	Ghana
Student 5	India

Table 1: Interview participants

After the interviews were transcribed, the first author conducted in-depth readings and re-readings of the transcripts to identify possible directions for analysis. The research team, inspired by the unique strategies that the international students appeared to be using to persist in the program, then decided to analyze the interviews with the framework of student resistance. Using this framework, the first author carried out a theoretical thematic analysis as outlined by Braun & Clarke [10] using the software NVivo 12. During first-cycle coding, she coded interview transcripts for instances of “exclusion,” when students mentioned feeling unsupported or isolated in any way within the program, and instances of “persistence,” when students mentioned strategies they used to continue the program despite the exclusionary aspects of the environment. During second-cycle coding, she grouped these exclusion and persistence codes into larger themes by creating a thematic map using NVivo’s concept map tools. Following Braun & Clarke’s steps for thematic analysis, she grouped together related codes and named the groups as themes. Some of these initial themes could be grouped into larger themes themselves, which she documented via the thematic maps. Throughout this process, she continually checked the themes back against the data. During the construction of the “persistence” thematic map, she identified whether any of the themes could be categorized as resistance, and reflected that in the map. Finally, she wrote up the analysis.

Results and discussion

Here we highlight the major themes around exclusion and persistence of the international student participants. The themes around exclusion shed light on RQ1, defining some of the challenges international students face in engineering programs. The themes around persistence relate to RQ2, showing some of the work these students do to persist despite the challenges.

Exclusion

Participants expressed being affected by various forms of exclusion, including those that could be applicable to all students and those that were more specific to international students. The thematic map for the exclusion codes is shown in Figure 1, and shows the codes as blue circles and the themes as orange bubbles. The themes in bold are the largest by number of participants who reported them.

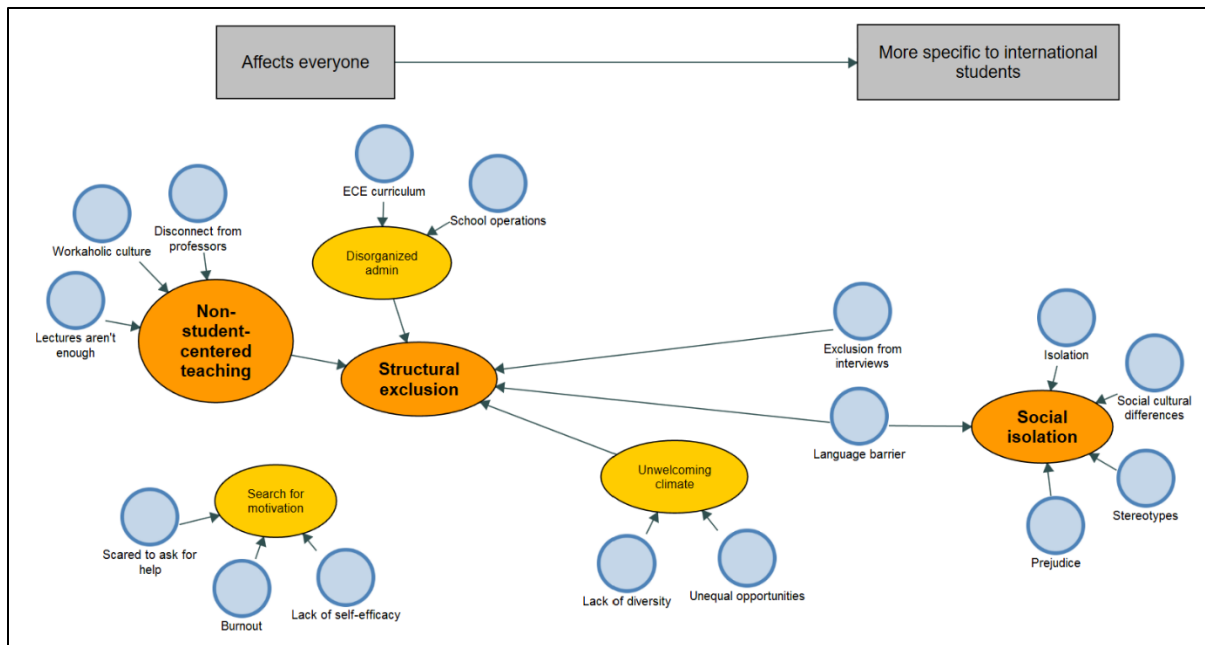


Figure 1: Exclusion thematic map

One theme that is applicable to all students was “search for motivation;” this describes students’ occasional feeling that they cannot or do not want to continue in the program. Some participants reported feeling not smart enough, fearing judgement for asking for help, or simply feeling burnout and a lack of motivation to finish their degree. These are all feelings that could arise in any engineering student since they have to do with students’ internal development and engineering programs are often very demanding.

A much larger group of exclusion themes applicable to all students had to do with “structural exclusion,” which describes aspects of the program and/or school that negatively affected students’ experiences. Student 5 described various aspects of a “disorganized admin” that excluded some students, noting a lack of disability or religious accommodations in the school, and a lack of sufficient guidance for students in choosing appropriate coursework. One of the largest themes relating to structural exclusion was “non-student-centered teaching,” which was observed by all five of the participants. Students felt that teaching in the ECE program was heavily lecture-focused, which was detrimental to their learning; that professors and coursework encouraged a “workaholic” culture, in which students were expected to sacrifice excessive amounts of time and even their wellbeing to complete the required work; and that many professors were unwilling to engage with and help students. Student 5 and Student 3 describe the themes around teaching succinctly:

“Some classes, in particular, are harder than they need to be. [...] I don't read the point of making classes that hard because we're just here to learn. And I feel we should focus more on teaching things in a more easier way than just throwing a lot of things at people and making it unnecessarily harder. [...] I feel it's more weed-out oriented. There's spikes in classes that make them unnecessarily hard in order to weed-out as many people. [...] Your lifestyle is just about work.”

– Student 5

“I have zero relationship with my professors. [...] I feel like for a lot of the professors, it's not really necessarily that they want you to succeed. It's more like, 'Here's the material and here's how you go about it. I'm just doing my job.' I feel like for a lot of them, being a professor is their secondary part of the job. They focus more on research. Student success is not necessarily essential. Maybe they have a few students that are prodigies and they focus on those ones, but I do not think that student success is one of the main goals of most professors on campus.”

– *Student 3*

Shifting towards structural exclusion that may especially affect international students was a theme of an “unwelcoming climate” in the ECE program that was noted by Student 3 and Student 4. Both of these students felt there was a lack of diversity in the school, with Student 3 emphasizing a lack of black students and Student 4 noting a lack of women. They also both felt there were not significant efforts by the school to improve diversity and inclusion. These students also felt there were unequal opportunities for different types of students in the program. Student 4 felt that nationality, gender, and race all had an impact on the opportunities available to students. Student 3 described feeling misled by the school’s promotional materials about available opportunities for professional development:

“What is presented over the media, all the projects, what they show you computer engineering is, is just a specific sect of students in computer engineering, who have gone out of their way, or who one or two professors have decided, ‘I like this kid,’ and put into a specific program with them.”

– *Student 3*

Another aspect of structural exclusion that was specific to international students was that students were rejected from job and internship opportunities based solely on nationality. Although the reason from the companies’ point of view was likely the effort and money required to offer students work visas, our international student participants saw this as unfair discrimination.

The language barrier, a common problem mentioned by participants, was another contributor to structural exclusion of international students. Participants noted that professors usually assumed students understood English well. Because of this assumption, professors expected students to learn readily from fast-paced lectures and to be able to read the textbooks instead of asking for help if they needed more explanation. Participants felt that many of their professors did not understand how difficult it was for them to fully understand lectures and textbooks if English was not their first language.

The language barrier contributed not only to the theme of structural exclusion but also to the final larger exclusion theme, “social isolation.” All five participants mentioned feeling some form of social isolation as international students. Because of the language barrier, participants felt excluded from socializing with domestic students. Student 1 describes difficulty working with a domestic teammate on a project:

“Okay so last semester when I was doing [a class] and we got I remember one American [in our group]. I think maybe it’s because we are not really good at

English speaking, so maybe the person will not be very comfortable to sharing an idea with us because they may think [...] we cannot give equal benefit or feedback to them. Maybe that would be the case. So [...] when I like text him say oh like, 'could you please take a look at some part,' well sometimes there was an answer, 'I'm quite busy,' and that's it. But in like Chinese group I can always like receive a message, so although they are busy right now, when they can reply [they will]."

– *Student 1*

Cultural differences also contributed to feelings of isolation for participants. For example, Student 1 also felt that American students were generally more concerned with their own performance, whereas their Chinese study group was more focused on the group's success. Student 1 also described struggling with making American friends because they could not discuss aspects of American pop culture, such as Marvel superhero movies.

Finally, stereotypes and prejudice also contributed to social isolation. Three participants told stories of domestic students assuming they were good at math because they were from Asia. Student 3 described prejudice in the school against black students:

"I do feel like I am looked down upon by some faculty and some students because of my appearance. [...] Sometimes I do feel like it is because I am a black student, that they approach me a different way than they approach other students, or they interpret my questions as stupid, versus someone who asked a question similar to mine, and they consider that question insightful. [...] I feel like a lot of professors are [inaudible] prejudiced towards certain types of students. They look a certain way. They talk a certain way. They dress a certain way. Their hair is a certain way. Or they are a certain gender. [...] Even amongst their peers, I feel like a lot of peers are not interested in talking to you or reaching out to you because of how you look in classes. I've been in a lot of ECE classes. People on the first and second day of class will reach out to the person beside them and be like, 'Let's study this material together.' Except if the person is black, that has never been the case of someone reaching out to me."

– *Student 3*

Existing literature has also identified social isolation as one of the most challenging barriers faced by international students. Sparks, Nandakumar, & Libii investigated the experiences of African STEM students in the US and found that they experienced stereotyping and racial microaggressions from domestic students, which could be confusing because they were not familiar with concepts of race in the US compared to Africa [11]. Joyce & Hopkins saw that in mixed engineering teams of domestic (UK) and international students, international students were reluctant to contribute due to language differences and domestic students sometimes began to ignore them and not allocate tasks for them. International students would then lose confidence and retreat to the periphery of the team, which domestic students could perceive as laziness or lack of ability [3]. In an Australian study, Robertson et al. found that international students reported social isolation as one of their biggest challenges in attending an Australian university, along with English language ability [12]. Notably, some of the university faculty and staff participating in the same study attributed international students' performance to a lack of ability

and unwillingness to participate, which corroborates our participants' feelings that professors sometimes do not understand the extent to which lack of language skills impact their learning.

Persistence

Participants described many strategies which they used to persist through the program. The vast majority of these strategies could be described as conformist behaviors and involved attempts by students to adapt both alone and with the support of others. A select few other behaviors could be described as avoidant, and one could be considered resistant by our definition. The thematic map for the persistence codes is shown in Figure 2. The codes are again represented as blue circles and the themes as green bubbles, with the most commonly reported themes in bold.

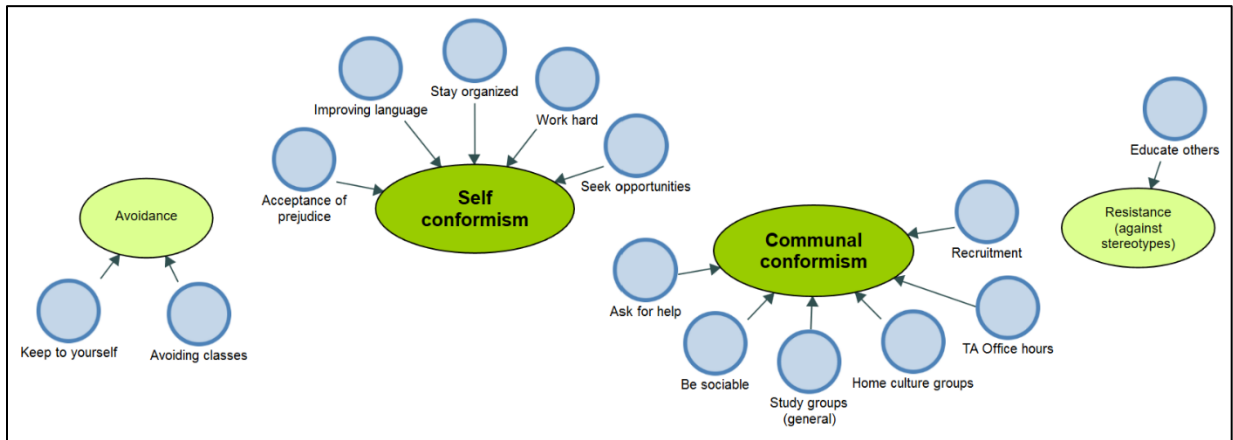


Figure 2: Persistence thematic map

Avoidant persistence strategies were those that involved students avoiding participation in the system (the school) in some way in order to have a better overall experience. One student mentioned avoiding certain classes that were known to be difficult or to be taught by unhelpful professors. Two students mentioned keeping to themselves and avoiding asking for help from professors and peers. Student 3 spoke of how they kept to themselves due to bad experiences engaging with others in the past:

“I feel like after my sophomore year, I stopped reaching out to professors or going to their office hours because I noticed this pattern of [...] especially if they didn't have a personal relationship with you, there's a natural bias to sit down with people that they liked. But people who just popped into the office every now and then for help, they didn't necessarily feel any obligation to sit down and really enlighten the student. [...] I definitely feel like [prejudice] has put me in a state where people do look down on me and people do feel like I'm not capable of the work that I'm being given. [...] I just ignore them because I don't want to cause a scene or anything. I just do my work and continue to move on.”

– Student 3

All of the participants exhibited some form of “self conformism,” or adapting themselves to perform as the system expected them to. Student 1 said they accepted prejudice and stereotypes and ignored them because they were “nobody's fault that's just how the world is running.” The

same student chose to take a communication course to improve their English language skills and better communicate with peers. To keep up with the extremely demanding workload in ECE, students stressed that they had to consistently stay organized and work hard in order to persist. They also emphasized that they had to be proactive in seeking opportunities such as projects, internships, and research, in order to reach their career goals. This was both because the program did not provide much guidance in gaining these opportunities and because participants felt their international status meant they needed more impressive resumes than their domestic peers to get jobs after graduation. Some of the ways students sought opportunities included attending career fairs, applying to internships and research programs, networking, and attending extra lectures about topics relevant to their careers.

Participants also exhibited “community conformism,” or adapting to the system with the support of others. Students described reaching out to professors and other campus resources for help completing assignments and making efforts to be sociable to avoid isolation. Students also stressed that reaching out to other students to study together was vital to their persistence; some did not think they would have completed the program if they had to study alone. Specifically, students valued the community they found among other international students from their same home countries or regions. This behavior of forming home-culture study groups was noted in this ECE department in a previous study of ours [13] and was one of the inspirations for this study. Student 1 and Student 4 describe how these groups have helped them persist:

“So I usually stay with the people who speak Chinese. [...] I think it's because we're from foreign countries. So when we meet here, we're just like wow. [They] feel like home, feel like families. [...] And then we can also talk to our comfortable language. So we can truly express what we feel about this question or think about this question with very smooth words [...] with very clear thoughts.”
– *Student 1*

“I actually had a group of friends, who were also international students, primarily from Nigeria. [...] Who collectively, we were able to teach each other concepts, help each other out with homework that we didn't understand. So for example, let's say for whatever reason, I couldn't go to class on the same day. I would know that one of my other friends did and he would be able to come back and teach me the concept in time for me to do the homework.”
– *Student 4*

These home-culture study groups are examples of diasporic communities, which “contribute to affirming conceptions of identity and help youth to imagine themselves apart from dehumanizing representations of their communities and countries of origin” [14]. International students form these groups as a way to ground themselves and find support within a larger system that is primarily structured for domestic American students. However, as we found in our previous study, many faculty of the ECE department see these groups as a hindrance because they are evidence that international students are unable or unwilling to integrate fully into the school [13]. Many of the faculty also believe that students should be highly independent and able to teach themselves concepts they do not understand [13]. Therefore, the formation of home-culture study groups could be considered an oppositional behavior because many of the faculty do not encourage it.

Another example of community conformism occurred through teaching assistants' office hours. Students found that TAs were more approachable than professors because they were more willing to help and were more like peers. At TA office hours, students not only received help from TAs, but also found help and community among other students there who were working on the same assignments. The final example of community conformism was Student 5's effort to recruit more minority students to undergraduate research opportunities, thus helping them adapt.

We observed one example of resistance in students' persistence behaviors, although it was resistance against racism in general and not the system of the school. This instance was when Student 4 had taken it upon themselves to educate other students against racial stereotypes. They explained that when they were stereotyped, they assumed it was due to domestic students' ignorance of other cultures and chose to educate rather than ignore it:

“This kind of stuff happens all the time to be honest. [...] For example, if someone I didn't know came up, and for whatever reason had a math problem to do, will just look at me and be like, ‘Yeah. You're probably good at math right? Because you look Indian.’ [...] I just kind of take it lightheartedly. I know a lot of people don't. But, I just take it as the person doesn't really know what they're talking about. So, I would rather be in a position to help them understand that that's not normal rather than to be offended and alienate them. [...] What message that gives me is, they're trying to make conversation and they don't know how. Or in very few cases, they're just being rude. [...] Most of the time, it's just them not knowing what to say.”

– Student 4

Where is the resistance?

Although we approached this study with resistance in mind, we identified very little resistance in analysis. This is partly due to our choice of a stricter definition of resistance that requires resistance to be rooted in both “critique of domination” and “struggle for emancipation” [4]. Others have labeled the formation of home-culture groups and diversity recruitment as resistance behaviors [15]. However, we exclude these from our conceptualization of resistance because they do not involve an effort to change a larger system, in this case the school or university. Home-culture groups exist to help students persist and diversity recruitment brings more students into the existing system, but both act on a symptom (numbers of minority or international students) without addressing the problems within the system itself (e.g., non-student-centered teaching, unwelcoming climate, lack of social support).

A second reason we did not identify much resistance among these international students may be that there is not much resistance happening. When we consider the context of these students, this makes sense. Usually, their families are paying large sums of money to send them to school overseas. They are living in a foreign country with little support outside of school for the sole purpose of obtaining a degree, which requires them to “play by the rules” of the institution. In other words, they have very little room to resist.

None of this is to say that students *should* be resisting more, or that engineering educators should encourage resistance. Although student resistance, namely student protests, have made changes

in universities before [16], [17], it is not the responsibility of students to change institutions to match their needs. Student resistance is a sign that students have been pushed into a corner and their institutions are no longer serving them. In this paper, we aim to identify problems and potential solutions to prevent reaching that point of no return. We also stress that whether these international students' persistence behaviors are labeled "resistant" or "conformist," they highlight gaps in institutional support that can be addressed by engineering educators.

Conclusion

Using the words of our five student participants, we have highlighted some of the ways international students feel excluded in engineering education, including structural issues like teaching styles and social issues like isolation, as well as some of the ways these students persist despite exclusion, which were primarily ways to adapt and conform to the US engineering education system, either alone or with the support of others. These students' experiences with engineering faculty and the lengths they have gone through to adapt show how international engineering students' challenges are often made invisible in the school at large. Engineering faculty may not be aware of how difficult it is for international students to adapt to a new culture and/or a new language while dealing with the workload of an engineering program, or they may blame international students' struggles on other factors like the students' ability [12]. We propose that the unique challenges of international engineering students be brought into the light so that institutional initiatives can be created to improve their engineering school experience.

This study suggests a variety of possible initiatives for international students (addressing RQ3). The first change that would help is improved teaching practices by faculty that do not rely exclusively on lecture and textbook learning, which students whose first language is not English especially struggle with. Engineering faculty can employ a wider variety of teaching practices, such as by supplementing lectures with active and collaborative learning, to appeal to a wider range of learners [18]. International students' feelings of isolation could be helped by multicultural and group communication education for both domestic and international students, as well as structured events for socializing between international and domestic students [3]. Finally, our findings about how our participants persist shed light on the value to international students of collaborative learning. Many international students foster collaborative learning through self-made groups, but institutional support for collaborative learning could go a long way toward helping students' learning and preventing isolation. Institutions can assign study groups early in engineering programs with a mix of domestic and international students (though it is vital that this be paired with guidance on communication to avoid tensions in the group [19]). Additionally, our participants found great value in TA office hours for both learning and finding community. Institutions can better harness the value of TA office hours by offering scheduled study halls with TAs and/or tutors available for popular and difficult courses. All of these initiatives would help not only international students, but all engineering students, including domestic students who also struggle with isolation.

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