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# Analyzing the Needs of Engineering Teaching Assistants: Examining Hidden Deficit Ideas

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# Analyzing the Needs of Engineering Teaching Assistants: Examining Hidden Deficit Ideas

## Introduction

The lack of preparation of graduate students for the professoriate has been documented by different scholars [1, 2]. It is well known that graduate education prepares students to pursue different career paths [1], but a large majority of engineering graduate students will follow primarily corporate and industry positions while a small percentage will chase faculty careers [3]. According to Choe and Borrego [3], doctoral international engineering students are more likely to pursue an academic career. Nonetheless, it has been argued that there is a lack of preparation in the graduate programs to support future faculty to become engineering educators – especially Black, Indigenous and People of Color (BIPOC) [4-7]. Research also shows that the most valued career path among doctoral engineering students is that of academia, but there is also a limited number of tenure-track positions that may be available for students in the future [3]. This trend means that future efforts for the preparation of graduate engineering students for the professoriate must involve actions that contribute to the professional development of future effective and equity-minded engineering educators with an emphasis on pedagogical methods. Prepared or not, the reality is that doctoral engineering students are going into the classroom to teach – as teaching assistants, contingent faculty, or tenure-track faculty – and they are both producing and reproducing dominant discourses in engineering. Without professional development, doctoral engineering students will continue to emulate the culture of engineering [8-10] in which they themselves were recruited into and have assimilated as their own.

Doctoral engineering students come into teaching often without receiving any professional development on the science of teaching and learning, developing curriculum, or creating a welcoming and inclusive learning environment [2]. As indicated by Golde [2], the life of a future faculty member – whether at a research university, community college, or primarily teaching institution of higher education – will require learning about pedagogical methods. Engineering, however, continues to be a field where research is the main focus among graduate students including an emphasis on recognition, performance, and competence [3], leaving aside the importance of being a an effective educator. Addressing the impact on the cultures of engineering, including the prevalence of deficit ideologies in engineering, on how future educators see themselves and how they see their own students is important for the implementation of better teaching practices.

In this work in progress, we seek to demonstrate how deficit ideologies manifest in the responses of engineering graduate students as they receive professional development in engineering education through a series of courses established at a minority-serving, very high research activity institution to better prepare them as engineering educators. The study was guided by the

question: How and in what ways does deficit thinking manifest in graduate engineering students' responses as they prepare to become future engineering educators? In this paper, we deconstruct historical roots of deficit ideologies that have historically impacted the students that engineering educators primarily serve withing the context of this study (i.e., minoritized students). The implications of this work include showing that deficit ideologies are deeply rooted in engineering, and to demonstrate that the devaluation given to teaching in engineering fosters negative attitudes toward effective and equity-minded pedagogical practices. We argue that getting to the root of the problem of deficit ideologies in engineering is important to deconstruct these beliefs and redesign actions that will truly support diversity, equity, and inclusion efforts in engineering education.

## Theoretical Framework

### *Deficit Ideologies*

We center the analysis presented in this paper on the premise that the dominant culture and discourses in engineering education go beyond the constraints of the engineering discipline – they are influenced by a pervasive deficit thinking ideology. We also consider important to highlight the place-based context of the institution given that a large number of students we serve are Latinos/as/xs. Even though there is limited amount of research on the history of engineering education in the region for Latinos/as/xs, understanding deficit thinking ideologies as a result of a historical context is important to dismantle the claim that Latino/a/x students come to engineering programs with inherent deficits [11, 12]. Historically, the education of Latino/a/x (primarily Mexican, Mexican American, and Chicano/a/x) students in the U.S. Southwest was flooded with instances of disproportionate funding, segregationist practices, and racialized ideologies of their communities in the name of Americanization [13]. Some of these actions led to the unsubstantiated belief that Latinos/as/xs carried inherent attributes and conditions that were to blame for their lack of success in school [14, 15]. IQ testing was put in place to "scientifically" demonstrate the inability of students to advance in educational settings, framing Latino/a/x students as mentally deficient, lazy, unhygienic, and culturally flawed [24]. Examples of the manifestation of deficit ideologies include: (1) the assumption that home language (other than English) could be a barrier for learning [16-18]; (2) the presumed incompetency of students based on race, gender, and other social identities [19, 20]; (3) the belief that community and household practices lead to cultural aspects that are to blame for not adjusting to the project of Americanization through schooling [13, 21, 22]; and (4) an overall tendency to blame the victim [20]. These ideologies were materialized by creating labels for Latino/a/x students such as Limited English Proficiency (LEP), disabled, inner-city, or remedial, which placed students with these labels as inferior, deficient, and in need of remediation or "fixing."

These deficit perspectives permeate not just elementary and secondary education, but also manifest in the way we create curriculum, give lectures, and prepare exams in higher education. Engineering education is not the exception. Davis and Museus [20] argue that deficit thinking is

a symptom of a larger system of oppression emerging from classist and racist ideologies, as well as being rooted as a response to the strong-hold beliefs on meritocracy, objectivity, and colorblindness. According to San Miguel [23], Latina/o/x communities historically were excluded from participation and decision-making processes in relation to their own education. This exclusion led to the prevalence of deficit thinking ideologies and its institutionalization, since the dominant narrative continues to be constructed under the premise of cultural inadequacy [15, 24, 25]. Thus, Latino/a/x education in the U.S. – particularly Mexican American education – has been framed as an instrument of oppression where *de facto* practices such as curriculum differentiation, school segregation, language suppression, and cultural exclusion became *de jure* [13, 22, 23, 26]. Valencia [22] indicates that Mexican American/Chicano education has been plagued with oppression in which institutions play a huge role on the way students are perceived, framed, racialized, and socialized into what is known as the Americanization process. The process of Americanization led to deficit ideologies about Mexican American students and perpetuated the ideas that students lacked intelligence, that their families were inadequate at providing basic education, that hygiene was not a priority for them, and that laziness was inherent [27] – ideas that continue to be present today in many classrooms.

Despite the resistance of the Latino/a/x and Mexican and Mexican American communities to reject deficit ideologies, states like Texas and California continue to see the lack of support even though these two states have the largest Latino/a/x population in the country [22, 28, 29]. For instance, Texas "has the longest and most pronounced history of inferior education in regard to Chicano students" [13, p. 23]. Thus, deficit ideologies continue to exist and to be present in engineering classrooms. Unfortunately, deficit ideologies are difficult to challenge, because "educators do not view themselves as part of the problem" and "there is little willingness to look for solutions within the educational system itself" [30].

### *Engineering Culture through a Sociocultural Lens*

Sociocultural theories have been used in engineering to describe how engineers identify with and create a self-concept of who they are as professionals as they face a world that may be different than their own (i.e., the world of engineering). Research in engineering education has explored the ways of knowing, doing, and being of engineers [8], the universalized narratives used to define engineering [9], the practices that delimit how engineering is practiced and conceptualized [10], and the environments that make engineering a hostile environment for minoritized populations [31-34]. In a world like engineering, we argue that learning and identity are inseparable, because they are both dependent on personal interactions where discourses, ways of knowing, being, and doing emerge from these interactions to construct identities [35-37]. As doctoral engineering students develop their own identity as future engineering educators, they also learn to emulate the behaviors and characteristics that they believe are representative of an engineering educator. This adoption and emulation of attitudes, behaviors and practices – in all forms of linguistic and symbolic units – serve the purpose of being recognized as engineering educators by peers, mentors, professors, and those who are part of the world of engineering [38,

39]. Thus, we posit that current discourses and practices of doctoral engineering students in the classroom, as they engage in teaching, are a representation of the current culture of engineering. That is, doctoral engineering students enact overt and subtle behaviors learned and adopted in engineering spaces throughout their undergraduate and doctoral programs such as a sense of superiority in their ability to solve problems [8], or even pervasive ideologies and values such as hyper-competitiveness [40], importance given to research [3], hyper-masculinity [36, 41, 42], or lack of tolerance to the difference that revolves around diversity [8]. It is these same practices and discourses that are representative of deficit ideologies, which are often neglected in engineering education doctoral programs. We argue that a deep analysis of deficit ideologies also should involve a critical analysis of the sociocultural practices in engineering to better prepare future engineering educators.

## Methodology

This study was conducted at a four-year, Hispanic-Serving Institution with a very high research activity located in the U.S. Southwest region. Aimed at preparing new doctoral students for teaching recitation sections and laboratories with majority Latino/a/x students, teaching assistants were required to take one of two engineering education courses as part of their funded assistantship. This requirement is also part of a new initiative from the College of Engineering to better prepare engineering educators. Although courses in engineering education became a requirement for engineering students, graduate students within different STEM departments also were allowed to enrolled in these courses. The preliminary data presented in this paper was the first engineering education course that they took as part of this requirement. It is important to note that the enrollment demographics included 53 doctoral engineering students of which a majority, 83%, held international student status.

To understand the complexity of how deficit ideologies manifest in this group of engineering doctoral students, a case study methodology was used [43]. Bounded by the place and time, the participants of this study took part in a course that they were required to enroll in because of their status as funded doctoral teaching assistants. The case also took place in a minority-serving institution with majority Latino/a/x enrollment and sought to investigate multiple dimensions of the graduate students' experience in the engineering education courses including their perceptions of undergraduate students enrolled in the courses where they acted as teaching assistants, challenges balancing studies, teaching, and personal obligations, and experiences implementing various teaching techniques in the classroom. Field notes were collected along with survey data, observations of participation in the courses, teaching observations in their courses, student-produced artifacts, and weekly self-reflections.

For this work in progress paper, we present data collected from a survey administered electronically through Qualtrics. The survey contained ten 5-point Likert-scale questions and five open-ended questions. The survey was administered to the students five weeks into the semester, and included one open-ended question in particular that sought to capture the doctoral students'

underlying beliefs about their own students and the challenges they encountered as teaching assistants. Thus, we gathered responses to the: What challenges do you still struggle with as you become an engineering educator? Preliminary results were drawn from thematic analysis [44] of the graduate students' responses. It is important to note that this question did not aim to draw out ideas about deficit ideologies. Instead, the question sought to give the instructors from both courses a glimpse into the students' challenges as they learned to use educational tools in their classes. After preliminary data analysis, we noticed that the responses contained several references to their own undergraduate students' beliefs, abilities, habits, and intentions.

During the semester when the case study took place, professors teaching the engineering education courses (Authors 1 and 2) met every other week to discuss the students' progress and make instructional adjustments whenever necessary. By meeting to reflect on the students' progress, professors shared the underlying beliefs that graduate students overwhelmingly held. So, a closer look at the survey data and reflections merited further analysis. The data in these results point to some of these deficit ideologies in greater detail.

## Study Limitations

Due to the nature of the case study design [43] (rather than a case-control design), an appropriate control or comparison group that included funded teaching assistants across the engineering disciplines that was not required to take the engineering education course was not identified. This study does not aim to generalize or allow for replication at other institutions. Instead, the present study aims to serve as a descriptive case of dominant engineering narratives and to delve deeper into deficit ideologies contextualized at a Hispanic-Serving, Research Tier 1, Institution. These beliefs are pervasive across educational contexts at all levels of instruction, and may be a root cause for much of the underrepresentation of Latino/a/x student participation in engineering. This discussion is meant to critically analyze these beliefs held by doctoral students of various backgrounds, both domestic and international regardless of gender or race. Additionally, due to the preliminary results of this study, future data-collection instruments specifically designed to examine the beliefs of engineering doctoral students and engineering faculty could be developed.

## Preliminary Results

Three general, preliminary themes emerged from the data. First, teaching assistants (TAs) blamed the students in their courses for their inability to engage them in the courses (i.e., blaming the victim [20]). Second, TAs attributed their lack of success reaching the students to external, limiting factors (i.e., presumed incompetence [19, 20]). Finally, TAs blamed themselves for not being successful teachers in the classroom (i.e., self-inflicted blame as the result of potential deficits).

### *Blaming Students*

The most salient theme is centered around blaming students for TAs not being able to engage their students with the course content. One TA said, “whenever I ask for student questions, only a student or two would ask”, and another TA said, “if they do not share where they are struggling, I cannot approach them and teach them better.” Here, the two TAs are not thinking about how the lesson activities could be better designed to engage students. Instead, the TAs placed blame on the students for the students’ lack of participation. Other TAs commented that there was a “lack of participation of the students” and that they could not “[get] students to read the assignment criteria” while another TA responded, “some students are not interested in some specific area.” This demonstrates deep deficit ideologies with externalized assumptions about what the students like or don’t like, how they engage or don’t engage, and most importantly, the views that they place on the students that they teach. There was no deep questioning of how the material could be made more engaging or relevant to the students, or what types of pedagogical practices could benefit students. The teaching assistants framed interest toward the subject under the presumption that interest and engagement would automatically come from the nature of the subject itself. That is, students disassociated their teaching practices from the subject and engagement was reduced to mere subject interest. While this may be a typical way of thinking among engineering educators, the root of these attitudes is grounded on the presumption that learning is the responsibility of the student alone and individual factors are seen as the cause of underachievement [20]. Without knowing much about their students, the TAs marked their students as deficient due to the TAs’ inability to “teach them better.” In some instances, the deficits were framed in terms of “laziness.”

Further analysis through a sociocultural lens shows that these responses carry beliefs about what they have learned the engineering culture to be—a privileged space for instructors (those who know and understand engineering) where student participation equals interest or abilities. In this culture, students are at fault for not asking questions, for not participating, and exhibiting these behaviors implies that students are not interested in the topics, or that they do not read assignment details [20]; all of which are assumptions based on deficit ideologies.

Another way that TAs excused themselves from their inability to reach students was by placing blame on the students’ attitudes. TAs voiced their challenges by stating that they had difficulties “manag[ing] students” because “they are angry”, they “behave in a bad manner with a TA,” “are shy [and don’t] want to actively participate”, “hardly respond”, or are “apathetic”. Perhaps these attitudes were highlighted by the teaching assistants, because while not expecting these responses, they left an impression on them, which they might have attributed to their inability to reach students. However, this is another clear indicator of how deficit ideologies manifest within the teaching of an engineering course. Engineering TAs believed that if their students are not participating, it must be the students’ fault. Rather than reflecting on how to create a learning environment where students could achieve a sense of agency and actively participate, TA’s instead blamed their own students for the behaviors that they perceived as contrary to the Americanization where the teacher – not the student – is the most important unit in the

classroom, discipline is the norm, and eliminating visible markers of difference is a priority [22]. This narrative also runs counter to the expected normative discourses of engineering such as rigidity and specific ways of knowing, doing and being.

TAs also placed blame on students' academic readiness. One TA said,

> students are not prepared for the current course…I am very surprised how they managed to reach such course. Some students have difficulties with angles and basic trigonometric functions which is not acceptable at a[n advanced level] engineering course.

This is a common deflection of blame which happens often across the educational system. Instructors of higher-level courses blame previous instructors or educational institutions for "passing" students. Many times, this happens prior to trying different methods for knowledge retrieval or engagement.

Several other statements about the students' academic abilities included, "they are from different levels, different backgrounds", and "students who don't have a sufficient background related to mathematics usually face problems while solving problems", and "the poor performing students are the challenge." Not understanding the systemic inequities that students faced throughout their schooling is clearly evident in these statements, along with a deficit view of undergraduate engineering students who appear to be under prepared. Framing the analysis of these deficit beliefs, doctoral teaching assistants inherently view their knowledge as superior to that which undergraduate students bring. Without having the tools to activate students' prior knowledge, doctoral students show frustration in their inability to reach students through the same tools that were used to teach them. However, rather than searching for ways to improve teaching methods, teaching assistants placed deficit views on the students' academic abilities.

### *External Limiting Factors*

Teaching assistants also stated that their challenges in the classroom were related to a "language barrier" or "communication". Others couldn't understand whether students "deeply understand what I taught", which points to a need to learn more about various assessment methods. Educators thinking this way now begin to place the blame away from the students but fault other external factors on their inability to reach students [30]. Using the sociocultural lens to frame these results, we can observe deficit beliefs about language [16-18]. The idea that students cannot learn well because of the different languages may be part of the greater educational culture, but appears to be embedded in some of the engineering TAs' beliefs tied to teaching and learning engineering concepts.

### *Blaming Themselves*

The final theme uncovered revealed a deep lack of self-confidence within the teaching assistants. One TA stated, "I feel like I should improve the connection with the students where they feel

more comfortable to ask questions even if it was silly ones or repetitive kinds of questions." This teaching assistant was looking for ways outside of the "norm" within which they believed would be appropriate to teach engineering concepts. In doing so, they implied going outside of their comfort zone, and implicitly, outside of the engineering culture, to reach students.

Another TA said, "I believe that I still struggle with over explaining and letting my nerves get the better of me, making me sound unconfident or unsure." These beliefs could stem from the TAs' awareness of their need to learn more about teaching and learning methods. However, placing blame of themselves also points to a deep deficit ideology about being quick to pick up knowledge and implement it with swift results, behaviors that are rewarded within engineering cultures. This is perhaps a deeply embedded and unconsciously emulated belief about the culture of engineering in general that manifests in deficit ideologies toward the self. It is important to mention the effects of self-blaming since this can create a blockage on how students see themselves progressing as future effective and equity-minded engineering educators, and the actions they need to take to embrace the ambiguity that comes with pedagogy. Unless this blockage is overcome, it is possible that graduate students may deter themselves from continuing to engage in good pedagogical practices and accept things "as they are" rather than practicing self-reflexivity [11].

**Discussion**

The preliminary results of this study explore deficit ideologies from a sociocultural lens embedded within the engineering culture. Teaching assistants manifest these beliefs through their own views of students' abilities and reasons for their challenges. Doctoral teaching assistants have been through the educational system successfully, and, we argue, have adopted the engineering cultural ideologies for their own benefit. When they teach others, these beliefs manifest in multiple ways including blaming students for lack of engagement, blaming external factors, or blaming themselves for using alternative methods for teaching that are outside the norm of what they have seen and learned from.

It becomes critical to address the deficit ideologies early in students' educational pathways before they permeate engineering TAs teaching, which then transfer to the students' learning. This can be done with a deep awareness of the structures that lead to deficit ideologies, including the institutional policies, gateway mechanism to engineering fields, exclusionary practices, and deeply held beliefs of leaders such as educational administrators and faculty. Reflection about our own beliefs about students and about the field of engineering need to be strategically and systemically considered a part of the problem-solving process to question, deconstruct, and abandon deficit ideologies. To alleviate the burden of carrying the deficit beliefs, it becomes critical to engage in self-reflection often with experienced engineering education equity specialists who can guide the novice engineering educators toward historical and contextual resources about how teaching and learning function. In the classroom, teaching assistants can remove the blame from the students and from themselves by getting to know the students as one

TA pointed out and by understanding the Americanized educational system, which continues to minoritize students and exclude BIPOC students and women from engineering fields.

Redesigning activities for greater student participation will also help engineering educators push the blame away from students; looking at the engagement results with a strategic lens will help TAs see engagement as data to analyze rather than through a deficit view that places blame on others. Reflection about their own ideas of knowing and learning can also help TAs recognize the privilege that they have been bestowed in the engineering culture that values these ways of knowing and learning. These strategies and methods for awareness about deeply embedded deficit ideologies become a critical first step to begin addressing equity within engineering education. The tools gained through educational methodology courses will help sustain and iteratively reflect on how the deficit ideologies in engineering fields can be deconstructed, making space to redesign lessons with asset-based approaches.

**Future Work**

It is imperative that we continue to explore how deficit ideologies permeate the world of engineering education. While this work in progress highlight some of the ways in which deficit ideologies manifest in engineering, more work needs to be done to explore the root cause of these deficit ideologies and how to uproot the practices that lead to such ways of thinking. Future work will involve additional interview data with graduate students that have gone through the engineering education courses to identify how these deficit ideologies are created, internalized, and perpetuated. In addition, an analysis of best practices in engineering education is necessary so that future engineering educators participate not just in implementing effective pedagogies in the classroom but also engage in praxis – or the reflection and action necessary to transform current educational structures in engineering [11].

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