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Mixed in Engineering: Introducing Critical Multiracial Theory to Engineering Education Research

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Introduction

According to the American Society of Engineering Education's By the Numbers report, multiracial students make up 4.2% of engineering undergraduate students. The multiracial, also know as mixed-race or two or more, category was defined as the following:

> Two or more: Persons who reported themselves as belonging to more than one of the race categories. These individuals should only be counted in this field and not any of the race categories [1].

Yet according to the National Science Foundation, "underrepresented minorities are defined to be "three racial or ethnic minority groups (Black or African Americans, Hispanics or Latinos, and American Indians or Alaska Natives) whose representation in [science and engineering] education or employment is smaller than their representation in the US population" [2]. However, in all cases, the multiracial category is lumped into an "Other" category, which typically includes American Indian/Alaska Native, two or more races, and nonresident aliens. It is also interesting to note that the US Department of Education includes Native Hawaiian and Pacific Islanders in the Aisan population [3]. Almost all reports cite the problem for lack of information with students who identify with two or more races.

Even now, mixed-race is not a significant enough number to be included in research but instead lumped together with other minority groups. For instance, in ASEE's Engineering By the Numbers report [4], the "two or more race" category is aggregated into an "Other" distinction which includes Pacific Islander, Native Alaskan, Native Hawaiian, and American Indian. Even with small numbers, researchers disservice these populations by grouping them all together, as this doesn't accurately paint a picture of what the actual demographics of engineering look like [5]. Mixed-race students in engineering are not properly included or engaged in engineering education research. Despite engineering programs and researchers have navigated the ways that racial identities have set barriers to underrepresented minorities, there is still a tendency in the engineering education literature to exclude mixed-race students [6], [7]. This leaves the mixed-race population to a citation or footnote or not even mentioning them in statistics given the "challenge" and "complexity" putting them in an appropriate category, which can impact support networks for underrepresented students [8]. By disengaging mixed-race students, engineering disservices a population of students that are continually left to the margins of inclusion in various aspects, such as resources and opportunities their peers may have. While spaces within engineering have borrowed various theoretical frameworks to explore experiences

of racially minoritized students in engineering, engineering education researchers should consider adding frameworks to expand upon mixed-race students' experiences. Critical race theory (CRT) has been used to explore racial identity in engineering [8], [9], [10]. However, CRT excludes nuances of race that are embedded in the mixed-race experience such as racial ambiguity, "passing," code-switching, and colorism [12]. Thus, engineering education should utilize Critical Multiracial Theory, or MultiCrit, building off of CRT, to explore the experiences of mixed-race students in engineering.

Developed in 2016, MultiCrit aims to expand eight tenets of CRT [12]. While MultiCrit's focus has been exclusively in the higher education space, MultiCrit should be extended into engineering education research. Engineering can utilize MultiCrit as a way to not only understand multiracial student experiences but understand and explain the experiences of non-white students in engineering. Engineering education research continues to explore how research on race in engineering can reject deficit paradigms [9], [10], [11], [13], [14]. MultiCrit acts as a more nuanced version of CRT, which includes ways for mixed-race students to have multiple racial and ethnic identities intersect.

This paper aims to explore the feasibility of introducing MultiCrit to engineering education research and employing it as a theoretical framework for analyzing the experiences of mixed-race engineering students who have been overlooked in existing literature. First, the background of CRT and its foundational role for the development of MultiCrit is discussed. Next, applications of MultiCrit in other social science disciplines, such as Communications and Developmental Psychology, will be examined to understand the use of MultiCrit in the social science context. Then, the potential limitations of MultiCrit are discussed. The paper closes with commentary on how MultiCrit can be used specifically in engineering education research.

Critical Multiracial Theory: A Primer

In the article "Towards a critical multiracial theory in education," Jessica C. Harris introduces the first intervention to extend CRT into the space of multiracial studies, through higher education [12]. MultiCrit can be considered a novel theoretical framework to explore race and identity in the engineering context as there are nuanced dimensions of race expanded on within the MultiCrit framework absent from CRT.

Before diving into the background of MultiCrit, laying out a firm definition is important for understanding this theoretical background, as this is a crucial element left out of the original MultiCrit. Multiracial, mixed-race, and two or more races throughout this paper refer to individuals who identify with more than two races [8]. Biracial refers to a specific multiracial identity where the person belongs to only two racial identities, for example, Black and Asian or

Pacific Islander and White [15]. Depending on the context, multiracial is typically referred to as a person of color (POC) and can be categorized as a minority group. However, multiracial as a *racial category* is often left out of research relating to STEM [8], thus the reason for centering multiracial engineering students in this project. Lastly, this paper refers to multiracial identity in the United States (US) context; however, multiracial identity also is abundant outside of the US.

CRT as Foundation for Exploring Multiracial Identity

Multiracial identity has been explored in various social science fields such as Ethnic Studies, Education, Higher Education, Legal Studies, Psychology, and Sociology, particularly by Root, who explored the intersections of multiracial development and Asian biracial identity in psychology [16], [17], [18], [19]. Similarly, Renn's work on multiracial identity in higher education has addressed multiracial identity formation [15]. As scholars have explored multiraciality through events like Loving v. Virginia and the 1990 US Census update to racial categorization with 'check all that apply', various aspects of multiraciality come to explain and explore racial dynamics and theories to understand multiraciality [20], [21], [22]. In most of these studies, CRT served as a background and foundation for MultiCrit.

CRT is a theoretical framework for exploring race through a critical worldview. Originated in critical legal studies, CRT challenges the normative nature of whiteness in the US, and the theoretical framework is grounded in the experiences of POCs [23]. CRT examines the lived experiences of those who have experienced racism as a result of whiteness, specifically experienced by the Black community. While CRT has been utilized particularly relating to the Black experience in the US, CRT has expanded to other notions of cultural identity, including Disability (DisCrit), Latina & Latino (LatCrit), Asian American (AsianCrit), and Tribal (TribalCrit). Along with these extensions, CRT has been utilized in various research fields, including engineering education research [9], [10], [13], [14]. Like engineering education has embraced CRT, MultiCrit can be a useful extension of CRT into the engineering space.

Critical Multiracial Theory (MultiCrit)

MultiCrit is a theory developed as an extension of CRT to provide contextual background for the specific intersectionality of multiracial women in higher education [12]. MultiCrit stemmed from Harris's dissertation on the racialized experiences of multiracial female students at a Predominantly White Institution (PWI). Harris found it challenging to utilize CRT as a major framework for her research as CRT mainly focuses on monoracial experiences. With no formal theory to explore multiraciality through the lens of higher education, MultiCrit developed as an extension of CRT to account for multiracial student experiences with race [12]. Harris's specific application centers on the intersectionality of multiraciality and female identity in the university setting. MultiCrit builds off CRT in a way that identifies two or more racial identities rather than

the typical monoracial lens from CRT. The eight tenets, or central beliefs, that make up MultiCrit are described next.

Tenets of MultiCrit

1. *Challenge to Ahistoricism:* Historical events in the US have been central to how the government and US have viewed multiracial as a demographic. Some important historical events include Loving v. Virginia (1967), the 1997 inclusion of the 'check all that apply' option on the 2000 US Census [12], Barack Obama as the first multiracial US president [24], and Kamala Harris as the first multiracial US vice president of Black and South Asian descent [25]. Unpacking these events in connection to multiracial identity is key to understanding how multiraciality is seen systematically. To continue moving toward a more diverse future, the past must be acknowledged and taught.
2. *Interest Converge:* Multiracial students have been leveraged, by white institutions, as pawns to promote and market a diverse setting. Multiraciality is utilized by white institutions to promote their own advancements, not necessarily the advancements for multiracial students.
3. *Experiential Knowledge:* Akin to experiential knowledge and standpoint theory from CRT, this third tenet focuses on centering multiracial student experiences as firsthand accounts. This could be seen through interviews with multiracial students about how they navigate the university setting.
4. *Challenge to Dominant Ideology:* The multiracial student experience challenges dominant white ideologies. Their racial ambiguity leads to confusion and contradiction in white society.
5. *Racism, Monoracism, and Colorism:* This fifth tenet highlights how multiracial students navigate nuanced race relations. While they may experience racism, they also encounter monoracism and colorism from their multiple racial identities. The individual may be a part of the ingroup but is also treated as an outsider due to having another racial identity.
6. *A Monoracial Paradigm of Race:* Conversations of race in the US tend to lean towards a Black/White binary, leaving little to no room for the inclusion of other racial groups outside the binary divide, here the multiracial category. Thus, MultiCrit aims for discussions of race to go further than just the Black/White binary and recognizes how race is seen in fixed categories rather than the reality that the multiracial category consists of blending together these categories.
7. *Differential Micro-racialization:* Dependent on the context, racialization has been used to serve different purposes to benefit the dominant group [26]. The timing of racialization is key in the context of higher education as multiracial students are "racialized differently on *a daily basis* to serve the needs of the white institution" [12].

8. *Intersections of multiple racial identities:* Multiple racial identities converge and intertwine into the multiracial individual's identity and experiences. Harris focuses on the intersection of mixed-race students and their other social identities, namely gender.

MultiCrit's Application in the Social Sciences

Since Harris's MultiCrit was published, a few other scholars have utilized MultiCrit to analyze multiracial identity in various spheres. As a framework, MultiCrit has helped guide researchers in framing literature reviews to disrupt the monoracial paradigm when investigating multiracial identity. In Communications, experiences of multiracial people have been used to examine the US Census as a non-human actant in perpetuating monoracial and white supremacy in the United States [20]. Research in Communications has also used MultiCrit to understand how knowledges, experiences, and narratives of interracial families are considered [27]. Developmental psychology also used MultiCrit to focus on narratives of Multiracial American youth through a systematic literature review [28].

In the field of Communications, MultiCrit, along with Actor Network Theory, was used to understand how the US Census as a non-human actant stabilizes monoracial ideologies and white supremacy in the United States [20]. The authors focus on the tenets of (1) challenge to ahistoricism, (3) experiential knowledge and racism, (5) monoracism, and colorism. In doing so, they found the Census actively contributes to excluding multiracial people and other racialized groups, stabilizes Asian American stereotypes, and continues to perpetuate monoracial assumptions [20]. This article focuses on the multiracial category for race identity and the instability of racial categories, as seen in the US Census. The article offers more details on the nuances of the category of multiracial identity and brings to light the concerns multiracial Americans have when filling out the US Census forms. This is important for engineering education research, as the tactics on racial and ethnic classification bleed into the ways that educational institutions understand racial and ethnic classification.

In another Communications study, MultiCrit is used as a way to understand the knowledge, experiences, and narratives of interracial families. Using qualitative methods, the author utilizes the MultiCrit tenets of (4) challenge to dominant ideology and (8) intersections of multiple racial identities to explore interracial family dynamics in interpersonal and family communication [27]. They "use empirical qualitative methods to explore MultiCrit's applied and theoretical value for our knowledge about interracial families and how they process and perpetuate their family narratives" [27]. The topics of this article focus on interpersonal and family communication (IFC) of family socialization research, specifically of interracial family narratives. It discusses mixed-race family narratives and how they are used to teach family members about race and family. As multiracial students must navigate interracial family experiences and bring their own

narratives, this research is insightful to the structures that multiracial students navigate at home. This is important for engineering education researchers to understand the experiences of multiracial students prior to entering the engineering space.

Continuing the exploration of interracial family narratives through Developmental Psychology, a "systematic [literature] review on qualitative and quantitative research available across disciplines regarding how caregivers engage in racial-ethnic socialization with Multiracial American youth to transmit knowledge about race, ethnicity, and culture" [28]. Using the MultiCrit tenets of (1) challenge to ahistoricism, (3) experiential knowledge, and (6) monoracial paradigm of race, the authors critique monoracially framed theoretical models to understand multiracial experiences. The authors argue for more interdisciplinary research, as the literature they found crosses several disciplines. White-Black mixed-race experiences dominate the literature on multiracial families. They also suggest disaggregating biracial experiences from multiracial experiences and unpacking how multiracial identities intersect with other social identities. The topics in this article focus on the racial-ethnic identities of multiracial individuals, inconsistencies of the terminology used on racial-ethnic socialization, and the ahistoricism and politicization of being multiracial. This can translate to engineering education research as this review can help engineering education researchers consider how mixed-race students bring their learned and lived experiences to the engineering environment.

Limitations of MultiCrit

With any theoretical framework, there are limitations that must be addressed. For the purposes of this paper's analysis, MultiCrit has four major limitations. First, "multiracial" is never defined throughout Harris's article. As previously mentioned, there is no clarity on what is meant by "multiracial"; however the definition is assumed. This can lead readers to misinterpret unintentionally, include, or exclude specific populations and can further complicate what groups are considered race or not. For instance, biracial or transnational adoptees may be included or excluded from MultiCrit. While it may seem obvious that multiracial claims more than two racial identities, Harris fails to define multiracial, for whom the theory is meant to articulate.
The second limitation of MultiCrit relates to the empirical grounding of the theory. Harris states, "MultiCrit is empirically driven, but not empirically grounded. In other words…the data are not meant to empirically ground MultiCrit as a solid, immovable framework" [12]. Harris points out that MultiCrit is not anchored to scientifically measurable or observable events, calling into question how strong of a theoretical framework it can be [12]. And since it has only been included in the literature over the past six years, MultiCrit may not be a significant enough theory for strong, rigorous quantitative research methods. Here might be a good place for CRT to come in, as CRT has been used for empirical research, and scholars who want to use MultiCrit should explore this thread further.

The third limitation of MultiCrit lies in how the tenet of "intersections of multiple racial identities" is described. The name of the tenet implies that perhaps the two social identities described in intersectionality consist of two or more racial identities of the multiracial individual. However, this tenet focuses on how mixed-race and gender come together as social identities. Future researchers have two ways this could be approached. The first would be to focus on the multiple racial identities as the intersectionality component of MultiCrit. The second would be to focus on how mixed-race, as one social identity, and another social identity, such as religion, gender, or sexuality, is experienced by the multiracial individual.

The fourth limitation is that MultiCrit was initially conceived and formulated in the context of a PWI university. While this was Harris's first exploration of MultiCrit, MultiCrit has not been explored at minority-serving institutions. For instance, perhaps the racial experiences at a minority-serving institution may not occur as frequently as at a PWI, or there may be more resources available to the multiracial student. MultiCrit could also change as the US gravitates towards a minority-majority future [29], [30]. Thus, further research is needed to explore if and how MultiCrit could differ at non-PWIs, and what MultiCrit might look like in the next ten or twenty years as the US becomes more multiracial.

MultiCrit as a Theoretical Framework for Engineering Education Research?

In terms of engineering education research, MultiCrit could be utilized in a plethora of ways. Seen with CRT's intersection with engineering education research [9], [10], [13], MultiCrit can be utilized by the engineering education field as a way to navigate the complexities of racial identity in engineering and further expand current theoretical frameworks for racial equity in engineering education. As MultiCrit is rooted in qualitative research methods, this framework can be useful for understanding first hand experiences and knowledges that mixed-race students bring to engineering, but also understand how these students navigate the engineering world and professional formation processes. Major research areas within engineering education research, especially those related to enriching and diversifying student experiences, such as sense of belonging, attainment and retention in engineering, and student support, could use the lens of MultiCrit to shape research projects and agendas. MultiCrit could be used to complement existing engineering identity frameworks to describe the lived experiences of mixed-race students' intersecting identities [31]. This framework could be a fascinating addition to intersectional work related to gender and embodiment identity, professional and occupation identity, religious identity, and LGBTQIA+ identity along with engineering identity [32], [33], [34].

While there is limited knowledge about multiracial student experiences in engineering, there is a large amount of research done in higher education. Utilizing the connections between engineering education and higher education can help administrators, faculty and staff, and others committed to working on diversity, equity, and inclusion. At the beginning of this paper, it was mentioned how engineering education would combine statistics of student demographic information if the numbers are low enough. Continuing to collectively count low student demographics into one category is not helpful and should be disaggregated to showcase the needed resources and attention for the underserved students in engineering. If multiracial students' experiences in engineering cannot be differentiated from their monoracial peers (which calls for more rigorous empirical research in engineering education), the opportunity to ensure all students have an equal opportunity to engineering education may be lost.

Similarly, understanding multiracial student experiences and MultiCrit can help aid administrators, faculty, and staff in identifying what the needs are of multiracial students, which can help these students succeed in their future endeavors. As it can be common for multiracial students to feel like they may not fit in with one racial identity, it is unknown whether multiracial students are fully immersed with their other racial identity(ies). Therefore, it is important to understand how multiracial student identity is formed, shaped, and enacted by various actors throughout a student's engineering career. If faculty and administrators are unable to support students holistically, including their identity development, they may be disservicing the students meant to be served.

Research on minority serving institutions and racial organizations have highlighted the benefits for providing resources to underserved students in engineering [36], [37], [38], [39]. Students of mixed-race backgrounds may face difficulty in finding communities due to rejection from predominantly mono-racial organizations [40]. And as mentioned earlier, mixed-race students are not always welcomed or included in these spaces meant to serve them. While this may require lots of change from students, faculty, and the university, we hope and call on engineering educators to help students find spaces where they are able to bring their entire identity to the classroom. This can help bring a new frame to the ways engineers design or tackle problems in engineering.

Conclusion

By highlighting the nuanced experiences of the mixed-race identity combined with a theoretical underpinning of CRT and the histories of racism in the US, MultiCrit should be utilized by the engineering education community. By understanding mixed-race experiences, engineering education can strengthen the experiences of all minority groups because of MultiCrit's various

angles. MultiCrit can help identify the nuances of the mixed-race experience, as well as help to inform and prepare future engineers for a more diverse and inclusive workforce.

As engineering educators, in what ways should we begin to think about mixed-race in our classrooms and labs? How do we effectively address the needs of mixed-race engineering students? Perhaps we allow these spaces to be more culturally relevant [41] or cultivate a more diverse faculty and administration. Another aspect for the future could be to integrate sociotechnical courses into engineering courses and curriculum to futher interrogate embedded systems of oppression within engineering [42]. This could help ensure we address the needs of the customers and communities that students will end up serving once they graduate. This is not just for the students to learn about themselves, but for educators to help contribute and create a more equitable and inclusive environments in engineering as a whole.

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