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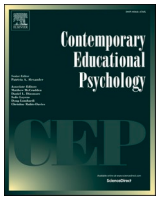

# Reclaiming and recasting: An anti-racist approach to psychometric instrument development☆

Angela M. White [a,*], Christy M. Byrd [b], Tanya A. Malloy [c]

[a] Johnson C. Smith University USA
[b] North Carolina State University USA
[c] North Carolina Agricultural and Technical State University USA

A B S T R A C T

The development of anti-racist quantitative measures is troubled by educational psychology's long reliance on quantitative methodologies that have reinforced White supremacy. To move the field of educational psychology forward, we must critically analyze and challenge methods that do not consider race and racism as realities for communities of color. This manuscript proposes grounding the development of instruments in critical, transformative frameworks such as Critical Race Theory (CRT) and Phenomenological Variant Ecological Systems Theory (PVEST). Considerable attention is given to the instrument development process, theoretical frameworks, and validation of the instrument. This paper highlights the use of a Critical Race Mixed Methodology (CRMM), which involves the combining of Critical Race Theory and Mixed Methods (DeCuir-Gunby & Schutz, 2018), to develop the first quantitative tool to measure the STEM identity of African American students while accounting for their racial identity and lived experiences with racism in STEM spaces. Essentially, this manuscript seeks to emphasize the importance of scrutinizing current methods and adopting a more nuanced approach that accounts for the role of power and racialized realities of communities of color.

## 1. Introduction

Research within educational psychology relies heavily on quantitative methods ranging from statistics to psychometrics which have perpetuated racism and a White logic of racial reasoning. Historically, statistical analysis and psychometric instruments upheld White Supremacy, as eugenic ideologies were at the heart of the development of statistical logic and psychometric instruments or tests (Zuberi and Bonilla-Silva, 2008; Bonilla-Silva & Zuberi, 2008). Current methods continue to reflect the racist ideologies that gave rise to them, which has resulted in whiteness functioning as the norm for many psychometric instruments. It is vitally important to consider how our research and methods reify oppressive ideologies and perpetuate dominant narratives. To move the field of educational psychology forward, we must critically analyze and challenge methods that do not consider race and racism as realities for communities of color. We must consider that "although the 'master' may have meant for scientific words to be used one way, reclaiming scientific tools, and recasting them for different purposes can benefit both science and subordinated groups" (Hill Collins, 1998, p.145). As such, we assert that anti-racist measures possess immense potential to challenge and interrupt dominant and deficit ideologies and narratives while simultaneously accounting for the unique histories and racialized educational experiences of those who have been marginalized. Our proposition suggests that educational psychologists can enhance the authenticity and accuracy of measuring constructs within communities of color by basing the development of instruments on critical, transformative frameworks like Critical Race Theory (CRT) and the Phenomenological Variant of Ecological Systems Theory (PVEST). This article emphasizes that quantitative research can be liberating for oppressed and marginalized groups and should be situated within critical research (Cokely & Awad, 2013). Our article and argument is aligned with Cokley and Awad (2013), that when researchers correctly employ quantitative methods, they are not antithetical to social justice but serve as a "self-correcting system of checks and balances" (p. 27).

This article offers guidance on creating anti-racist scales and introduces a novel, multidimensional STEM identity measure incorporating racial identity and racism. It extensively addresses the instrument development process, theoretical frameworks, and validation. Focused on our Multidimensional African American STEM Identity Instrument (MAASI), the aim is to steer educational psychology and STEM Education towards an anti-racist stance in research, interventions, and programming. The article is structured into four key sections: (1) critiquing the conventional role of measurement in educational psychology; (2)

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* Corresponding author.
*E-mail address:* awhite@jcsu.edu (A.M. White).

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exploring Critical Race Theory and Phenomenological Variant of Ecological Systems Theory; (3) detailing the use of critical race mixed methodology for anti-racist instrument development; and (4) presenting implications highlighting the impact of this shift in instrument development on the field of educational psychology.

## 2. Traditional role of measurement in educational psychology

The development of anti-racist quantitative measures within educational psychology is hindered by its historical reliance on methodologies that perpetuated White supremacy. Early quantitative methods, rooted in positivism, upheld a hierarchical and biologically determined view of race, reinforcing White dominance (Cummings & Cummings, 2021). Educational psychologists, influenced by White supremacist ideologies, created measures that marginalized and caused harm to people of color, exemplified by eugenicist Robert Yerkes' development of IQ tests during World War I, contributing to lasting ethnic-racial disparities in standardized tests (Reeves & Halikias, 2017; Reynolds, Altmann, & Allen, 2021).

While the field later shifted towards cognitive and social constructivism in the late 20th century, it failed to critically acknowledge and address the foundational biases of its earlier methods. Cognitive constructivism focuses on how individuals actively construct knowledge through mental processes; however, it may not explicitly consider the broader social, cultural, and systemic factors that contribute to educational disparities and perpetuate racism. Racism, as a systemic issue, operates at societal and institutional levels, which may not be fully addressed within a strictly cognitive framework. This shift allowed research conducted primarily with White students to be considered universal and value-neutral (Usher, 2018; Zusho & Clayton, 2011). Consequently, culturally-biased measures and theories developed in predominantly White samples were uncritically applied to diverse populations without testing for equivalence (Knight, Roosa, & Umana-Taylor, 2009). Over the years, the Eurocentric intent of quantitative methods of research has yielded ethical tensions amongst communities of color or collectivist communities (Cokely & Awad, 2013), as findings oftentimes do not represent the experiences of these populations. Therefore, this dominant methodology has been viewed as oppressive to marginalized communities instead of liberating or revelatory.

Despite calls for more culturally relevant methods and attention to students' sociocultural contexts, issues of race and culture in educational psychology have often been marginalized. Special journal issues may feature these topics, but integration into the broader field remains limited (Kumar & DeCuir-Gunby, 2023; Strunk & Andrzejewski, 2023). To promote anti-racism and decolonization, a critical reexamination of the field's methods and assumptions is imperative. Scholars have advocated for "culturalizing" educational psychology, emphasizing the role of culture, social justice, and integration with fields like multicultural education (Kumar et al., in-press; Parajes, 2007). In this paper, we exemplify the use of critical race mixed methodology as a tool for developing anti-racist measures, emphasizing the centrality of race and racism throughout the entire process. Throughout history, the integration of critical theories of race within quantitative research has posed a challenge to paradigms rooted in positivism, empirical-analytic approaches, or objectivist research that have been strongly influenced by whiteness (Bonilla-Silva & Zuberi, 2008; Garcia et al., 2018; Guiliano, 2011; Knowles & Hawkman, 2020; Tabron & Thomas, 2023; Westmarland, 2001). To address this, the current article will spotlight two prominent critical theories of race and explore how these theories can be applied to enhance and inform quantitative analysis (Covarrubias & Velez, 2013; Gillborn et al., 2018). The authors will specifically use PVEST and CRT to demonstrate how to transform quantitative methods or instruments into mechanisms to promote social justice for oppressed and marginalized groups. The intent of this article is to demonstrate quantitative methodologies are not inherently oppressive when correctly employed through the lenses of CRT and/or PVEST.

## 3. Critical Race Theory

Since the mid-1990s Critical Race Theory (CRT) scholars within the domains of law and education have stressed the importance of scholars positioning race at the nucleus of their analyses. CRT originated from Critical Legal Studies (CLS), as it emerged in the 1970 s to radically address the collective racialized experiences of people of color and to address forms of institutional and covert racism (Delgado et al., 2012; Delgado et al., 2013; Parker, 2015). Ladson-Billings and Tate's introduction of CRT into education in 1995 (Ladson-Billings & Tate, 1995) stimulated educational researchers to explore ways in which race manifests itself to construct oppressive educational systems and experiences for students of color in what appears to be "race neutral" spaces with regards to pedagogy, policy, and curriculum (Lynn & Dixson, 2013). As the special issue seeks to shift educational psychology research towards anti-racist methodologies, we pause here to highlight that the purpose of inquiry from a CRT-framework is oriented toward social transformation and dismantling systems of racism and oppression while traditional positivist inquiry solely seeks to explain and predict phenomena based on empirical data.

As emphasized by Ladson-Billings (2013), simply writing about race and racial issues does not make an individual a critical race theorist. Authentic CRT scholars align their practices with the core tenets of CRT as outlined by Delgado and Stefancic (2005):

Racism is permanent and normal in American society.
Interest Convergence
Race as a social construction.
Counter-storytelling.
Intersectionality
Whiteness as property

Ontologically, CRT perceives reality as socially constructed and stresses that different social groups experience reality in different ways due to systemic inequalities. Conversely, positivism suggests that there is one objective reality that exists independently of human perceptions and this reality can be understood through empirical research. Critical race theorists, exemplified by Derrick Bell and Alan Freeman, assert that racism will permanently pervade American society, viewing race as a socially constructed concept (Bell, 1992; Delgado and Stefancic, 2005; Dixson, 2006; Freeman, 1978). Within educational psychology, CRT calls for a critical examination of how racial categories are conceived in instruments, urging scrutiny of assumptions to align with race as a social construct. Instruments must reflect the intricate nature of racial identities, considering historical and social contexts. Educational psychology tools should probe racialized individuals' lived experiences, addressing systemic racism, stereotypes, and racial identity development for a nuanced understanding guided by critical race theory.

The CRT idea of *interest convergence* serves as a descriptive feature of a racist society by highlighting the dynamics and conditions under which progress toward racial equality is likely to occur. The concept, introduced by Derrick Bell, suggests that advances in racial justice are more likely to be embraced and implemented when they align with the self-interests of those in power, particularly white elite. To this end, steps towards addressing the marginalization of Black people are not solely pursued for their sake and to actualize social justice, but because they serve the interest of white people holding power.

Epistemologically, CRT's functions by a constructivist and critical epistemology, such that knowledge is socially constructed and significantly influenced by racial power structures. In contrast to positivism which asserts that an objective truth can be obtained through observation and empirical measurement, CRT posits that objective truth is shaped by dominant narratives and is not neutral. Therefore, CRT strives to challenge and deconstruct dominant knowledge production that perpetuates and fortifies racial inequalities. CRT scholars utilize *counter-storytelling and counternarratives* to expose the daily, pervasive, and

multifaceted racism faced by people of color (Brown & Jackson, 2013; Matsuda, 1995; Hill Collins, 2000). This method goes beyond extracting stories from Black participants and normalizes the experiences and voices of those oppressed by racial discrimination (Matsuda, 1987). Educational psychology, unintentionally perpetuating systemic inequalities, can be transformed through CRT counter-storytelling in instrument development. This approach critically examines power dynamics, considers narrative-shaping structures, and emphasizes contextualization within historical, cultural, and social contexts. Constructing counter-stories involves authentic collaboration, recognizing agency, empowering individuals to shape narratives, and contributing to a more just society.

Critical race theorists intentionally examine the unique position of Black women, situated at the intersection of race and gender oppression (Crenshaw, 1991, 2011). The CRT concept of *intersectionality* serves as a framework to explore the social construction of oppressive structures and understand their varied impacts on individuals within multiple social groups. This has significant implications for instrument development in educational psychology, emphasizing the need to consider and capture the multifaceted nature of individuals' identities rather than treating them as isolated categories. Traditional psychometric instruments oversimplify identity categories, while intersectionality suggests a more nuanced and comprehensive approach is necessary to capture the dynamic nature of various social identities.

Another foundational CRT principle, articulated by Cheryl Harris (1993, 1995), is the concept of *Whiteness as Property*. This idea suggests that whiteness possesses a tangible property-like quality based on individuals' phenotypic appearance and sociopolitical status. The legal system plays a significant role in solidifying and perpetuating whiteness as a form of property. Through legal mechanisms, white individuals gain privileges, authority to exclude non-Whites, and the ability to transfer advantages. The CRT notion of Whiteness as Property has implications for instrument development in educational psychology, prompting a critical examination of existing instruments to ensure they do not perpetuate privileged whiteness. Researchers are challenged to reevaluate and modify instruments, considering how they may reflect and reproduce societal structures that advantage perceived whiteness. For example, the Scientist Identity Scale developed by Chemers et al. (2011), loosely based on the racial identity work of Sellers et al. (1998) and the original population consisted of underrepresented students in science, technology, engineering, and mathematics (STEM). However, the development of the items was not guided by a critical framework, such as Critical Race Theory, and did not draw from the lived experiences of minoritized populations. Instead, the framework focused on social cognitive theory and identity theory, with the intent of exploring how factors such as self-efficacy, sense of belonging, and mentorship contribute to the development of a science identity among undergraduate students in STEM while overlooking the how racialized experiences, white STEM cultural norms, and stereotypes shape science identity development for minoritized students. The item development process was primarily based on existing literature on self-efficacy, science identity, and social belonging which has not heavily focused on African American/Black students. An item from the Scientist Identity Scale is "I have a strong sense of belonging to the community of scientists". A modification of this item through the lens of CRT and drawing from the lived experiences of African American/Black students may be phrased "I have a stronger sense of belonging in Black STEM spaces compared to white STEM spaces". While the original item aligns with the neutrality of positivism, the modified anti-racist version of the item reveals power relations and accounts for the role structural, systemic, contextual, or sociocultural factors play in the identity development of African American/Black students. The validity and fairness of instruments must be assessed to accurately capture the experiences and abilities of individuals from diverse racial backgrounds.

### 3.1. Phenomenological variant of ecological systems theory (PVEST)

Another transformational critical theoretical perspective that provides a comprehensive framework of human development, particularly for individuals from marginalized social groups, is Phenomenological Variant of Ecological Systems Theory (PVEST). Dr. Margaret Beale Spencer's PVEST, a fusion of phenomenology and ecological systems theory, offers a framework for examining how identity development interacts with embodiment, decision-making, and social regulations to predict individual outcomes. It emphasizes the significance of meaning-making processes in identity development and responsive behaviors (Spencer, 2021). The PVEST framework, vital for anti-racist research and instrument development, is built on five core components: net vulnerability, stress engagement, reactive coping mechanisms, emerging identities, and life-stage outcomes (Spencer, 2006; 2021). It is important to note that PVEST combined with CRT offers a comprehensive anti-racist framework that lends to a holistic understanding of how race, identity, and systemic racism interact over time. Specifically, PVEST illuminates the role intersecting factors (i.e. race, gender, environment, socioeconomic status) play in the identity development processes, while CRT exposes the structural and systemic forces that shape these processes. Moreover, PVEST allows the researcher's lens to focus on the coping strategies utilized by the population to navigate systems of oppression and the role of environmental contexts or social supports (i.e. school, family, community) in molding an individual's experiences and identity.

An extension of Ecological Systems Theory (Bronfenbrenner, 1977; Bronfenbrenner & Morris, 2006), PVEST provides researchers with a clearer understanding of a person's immediate, personal and developmental contexts impact their development. We believe this makes PVEST appropriate for anti-racist instrument development, as it illuminates the role the context plays in molding individuals' experiences and outcomes. By combining the PVEST framework with CRT, which emphasizes broader social structures, researchers gain insight into both the micro (individual) and macro (systemic) factors that collectively impact the experiences of marginalized communities.

PVEST examines an individual's *net vulnerability*—balancing risk contributors and protective factors—and *net stress*—evaluating challenges and social support—influencing development. Net vulnerability refers to the cumulative risks and stressors that individuals face based on their social position and can lead to stress if challenges outweigh supports. These vulnerabilities play a role in how they perceive themselves and other individuals, thus play a key role in the development of their identities. The net stress embedded in the context is filtered through self-appraisal processes, leading to the adoption of reactive coping strategies, which can be either adaptive or maladaptive. While CRT does an excellent job with highlighting how systemic racism and institutional biases affect African American/Black students with regards to access, retention, and success, CRT alone cannot fully capture the developmental or negotiation processes these students engage in over time to develop their identity. Without the inclusion of PVEST, an instrument may not capture how individual experiences with racism and other stressors interact with personal and contextual factors to shape the evolving or emerging identity of these students. The instruments may not capture how they cope with racism and adapt to challenges that result from systemic racism. As individuals cope with risks and protective factors, *maladaptive or adaptive coping strategies* emerge, becoming *emergent identities*. Maladaptive coping, if unchecked, manifests as one's identity, while adaptive solutions contribute to positive emergent identities, influencing *life stage outcomes*. Spencer's conceptualizations focus on individual identity like academic identity or in our scenario STEM Identity, while social identities (e.g., race, gender) are linked to specific social conditions (Cunningham et al., 2023).

PVEST offers several core components conducive to an anti-racist approach in educational psychology instrument development: phenomenology, ontology of becoming, ecological systems, agentic

motivation, and a developmental lifespan perspective. Phenomenology challenges positivism by emphasizing understanding subjective experiences, aiding researchers in recognizing and valuing diverse lived experiences, especially across racial backgrounds. The ontology of becoming highlights individuals' continual evolution, countering static views and essentialism that may contribute to racial stereotypes. PVEST's ecological systems framework acknowledges racism's operation at multiple levels, challenging positivism's tendency to isolate variables. By examining the impact of racism across different ecological layers, researchers can develop instruments that capture the complex interplay between individuals and their environments. Agentic motivation underscores individuals' active role in shaping their development, crucial in an anti-racist approach to capture proactive responses to racial challenges. Incorporating a developmental perspective recognizes the evolving impact of racism across the lifespan, ensuring instruments reflect dynamic responses to racial experiences. In summary, PVEST components provide a theoretical foundation aligning with an anti-racist approach, fostering instruments that authentically capture racial complexities for a more equitable educational psychology. By centering individuals' subjective experiences, acknowledging their agency, and considering the dynamic nature of development within ecological systems, researchers can create instruments that more authentically capture the complexities of racial experiences and contribute to a more equitable and just educational psychology.

Both PVEST and CRT provide distinct, yet complementary frameworks for understanding the developmental processes of marginalized individuals within systemic contexts. When incorporated into quantitative research, these two critical frameworks provide a potent way to operationalize critical race perspectives. By employing PVEST, with its emphasis on identity development and coping mechanisms within ecological systems, researchers can quantify how individual experiences of race, vulnerability, and resilience mold developmental outcomes. Once CRT, with its critique of structural and systemic racism is added to the equation, researchers gain a lens to quantify how these broader forces affect marginalized populations. In the next section we discuss using Critical Race Mixed Methodology (CRMM) to develop anti-racist instruments. As such, the integration of CRT and PVEST will allow researchers to blend the strengths of both qualitative and quantitative approaches to construct robust anti-racist instruments that not only capture individual outcomes but also the systemic structures that influence these outcomes.

### 3.2. Critical race mixed methodology (CRMM)

Studies applying CRT often lean towards qualitative methods, emphasizing CRT's focus on exploring marginalized groups' lived experiences (DeCuir-Gunby & Walker-DeVose, 2013; Garcia et. al., 2018). Opinions differ on CRT's compatibility with quantitative methods (Sablan, 2019). Some argue that positivistic/post-positivistic approaches linked to quantitative methods may not align with CRT's critical and subjective nature, questioning their objectivity (DeCuir-Gunby & Walker-DeVose, 2013; Zuberi and Bonilla-Silva, 2008). Others contend that quantitative methods can align with CRT through critical quantitative approaches, constructing "group" or "composite" counter-stories (DeCuir-Gunby & Walker-DeVose, 2013; Sablan, 2019). Advocates suggest that strategically applied quantitative methods can contribute to constructing counter-narratives, revealing systemic patterns of oppression and collective experiences. The debate centers on whether traditional quantitative methods suit CRT's critical nature, with some noting limitations in capturing systemic racism, while others argue for their potential contribution with a critical lens.

### 3.3. Mixed methods

Mixed methods research offers a robust alternative for exploring intricate processes and research inquiries, defined as the collection and analysis of data, integration of findings, and drawing inferences using both qualitative and quantitative approaches within a single study (Tashakkori & Creswell, 2007). This method strategically combines qualitative and quantitative data to leverage the strengths of each, providing a more comprehensive understanding of research findings. While quantitative research offers generalizability and causality, qualitative research delves into how phenomena occur, develops theories, and describes lived experiences (Fetters et al., 2013).

Integration is central to mixed methods research, amplifying the value of information gathered (Creswell and Clark, 2011). This intentional action connects qualitative and quantitative phases, methods, and data, allowing qualitative data to validate and expand quantitative findings and vice versa. Additionally, qualitative inquiry informs the development of quantitative instruments, contributing to the creation of culturally specific and anti-racist tools (O'Cathain et al., 2010; Creswell & Plano-Clark, 2018).

Integration occurs at the study design level through three mixed methods designs: exploratory sequential, explanatory sequential, and convergent (Fetters et al., 2013). In an exploratory sequential design, qualitative data informs subsequent quantitative data collection, while in an explanatory sequential design, quantitative data is elaborated upon by qualitative data (Onwuegbuzie, Bustamante, & Nelson, 2010; Ivankova, Creswell, & Stick, 2006). Convergent or concurrent designs involve simultaneous collection and analysis of both qualitative and quantitative data. At the methods level, integration is achieved through connecting, building upon, merging, and embedding data sets (Fetters et al., 2013). This multifaceted approach enhances the depth and breadth of insights gained from mixed methods research, making it a valuable tool in addressing complex research questions.

### 3.4. Integrating critical race theory and mixed methods

Mixed methods research has traditionally focused more on data collection and analysis methods than on theoretical frameworks, often leaning towards a quantitative-dominated approach influenced by positivism or post-positivism (Giddings, 2006; DeCuir-Gunby & Walker-DeVose, 2013). However, there is a growing recognition of the need to incorporate theoretical perspectives, especially considering issues of social inquiry, power dynamics, and social justice.

In response to this shift, the integration of CRT into mixed methods research becomes crucial. CRT, known for its emphasis on power dynamics and systemic change, offers a transformative-emancipatory framework that aligns with contemporary research goals (Mertens, 2009; DeCuir-Gunby & Walker-DeVose, 2013). DeCuir-Gunby & Walker-DeVose (2013) advocate for the integration of CRT and mixed methods, introducing the concept of Critical Race Mixed Methods (CRMM). This approach prioritizes qualitative methods, particularly through counter-storytelling, ensuring considerations of race and racism are interwoven throughout the entire research process.

### 3.5. Exploratory sequential critical race mixed methods design

This article focuses on employing the exploratory sequential design within CRMM for developing anti-racist instruments. Recognizing the limited guidance on meaningful integration in mixed methods instrument development, particularly in the context of CRT, the article emphasizes the building and merging techniques.

In the exploratory sequential design, the process unfolds in three phases. The initial qualitative phase, given its prominence in CRMM, serves to build a quantitative instrument. This approach is valuable for crafting context-specific instruments, especially concerning black and brown populations (Creswell & Plano-Clark, 2018; Onwuegbuzie et al., 2010). The integration of qualitative and quantitative data, enriched by participants' lived experiences, renders CRMM advantageous for instrument development (Creswell & Plano-Clark, 2018; Onwuegbuzie, Bustamante & Nelson, 2010; Zhou, 2019; Younas et al., 2020).

The building approach involves utilizing qualitative findings to develop instruments for subsequent quantitative phases (Fetters et al., 2013). Concurrently, the merging technique entails comparing qualitative and quantitative findings during analysis, discussion, and interpretation phases. As an extension, the article proposes constructing composite counternarratives during merging, aligned with CRT, capturing a richer understanding of participants' perspectives and experiences.

For the building technique, the qualitative phase begins by drawing from CRT tenets to develop interview and focus group protocols addressing research questions and instrument purpose. Semantic level coding is initiated, focusing on explicit meanings, with in-depth interpretation reserved for later stages. Themes and subthemes are analyzed through the CRT lens, ensuring alignment with central tenets and relevance to the instrument's purpose. The subsequent phase involves linking themes back to participants' direct quotes, emphasizing their lived experiences. This linkage allows a second examination of themes and subthemes, facilitating the selection of words and phrases to construct instrument items.

The merging technique becomes crucial in the final phase, enabling the comparison of qualitative and quantitative data to generate confirmed, discordant, and expanded conclusions for reporting (Creswell & Plano-Clark, 2018; Fetters et al., 2013). In the context of CRT-aligned instrument development, this approach goes beyond traditional merging methods. It suggests the creation of composite counternarratives, acknowledging the importance of counternarratives in CRT as stories that challenge dominant narratives and expose systemic injustices.

To implement this technique, researchers begin by carefully examining qualitative findings through the CRT lens during the analysis, discussion, and interpretation phases. The goal is to identify themes and subthemes that reflect the participants' lived experiences and perspectives on race and racism. Traditional merging involves data transformation and joint displays, but in the CRT context, researchers extend the process to construct composite counternarratives. Composite counternarratives amalgamate individual narratives, capturing the collective experiences of participants. This approach recognizes the diversity within the marginalized group and emphasizes the interconnectedness of their stories. It allows researchers to unveil patterns of systemic racism, power dynamics, and resistance that may not be evident in individual narratives.

### 3.6. *Multidimensional African American STEM identity (MAASI) scale development*

Frameworks emphasizing STEM identity are crucial for predicting student persistence and success in STEM fields (Carlone & Johnson, 2007; Hazari et al., 2013). However, the limited application of these frameworks to African American STEM students highlights a significant gap (Stets et al., 2017; White et al., 2019). Carlone and Johnson's foundational work (2007) provided a widely used science identity framework, yet it overlooked the intentional consideration of race and racism's impact on science identity development for women of color. This oversight in existing STEM identity models impedes anti-racist interventions for African American students in STEM, who encounter distinct challenges within the racialized STEM hierarchy (McGee, 2016). To bridge this gap, we employed both CRT and PVEST in an exploratory sequential design to craft the Multidimensional African American STEM Identity (MAASI) Scale. Our mixed methods design engaged African American STEM students from a southeastern Historically Black College and University (HBCU) through focus groups, semi-structured one-on-one interviews, and cognitive interviews. Developing MAASI items involved qualitative data analysis grounded in CRT and PVEST, ensuring a comprehensive understanding of the intricate dynamics.

The integration of both CRT and PVEST in the development of MAASI was crucial rather than exclusively framing it with CRT. Starting the instrument development through focus groups and semi-structured one-on-one interviews unveiled that STEM students engage in self-appraisal processes prompted by societal stereotypes, microaggressions, and biases. A clear example of this process was uncovered when the participants were asked "Tell me how you engage in STEM-related activities in predominantly Black STEM spaces, as well as in white STEM spaces". Some of their responses included: "When I'm in a Black STEM space, I feel like I can just be a student instead of a representative of Black people", "They don't expect you to thrive in those spaces", and "Especially in internships, you're not expected as a black person to know certain beyond a certain level". This discovery underscored the necessity of incorporating PVEST into our study, given its emphasis on the meaning-making process within ecological systems. Our subsequent goal was to comprehend how STEM students interpret their experiences, navigate challenges, and shape their identities within this context. This encompassed capturing cognitive processes, coping mechanisms, and the influence of historical and systemic factors. We observed that cognitive-based appraisals of stereotypes and biases intersected with STEM identity development, particularly when students acknowledged stereotypes about African Americans in STEM. Utilizing both CRT and PVEST, our questions aimed to uncover the types of stereotypes and racism towards African Americans perceived or experienced by participants. Through the lens of CRT, our participants revealed the endemic nature of racism in STEM through statements like "the system [to gain access to STEM learning experiences or jobs] was built for them", "I feel like in predominantly white STEM spaces, I kind of feel the need to keep my guard up…", "I don't see people like me in my field", "Compared to Black people, White people have more advantages and get more opportunities in STEM", and "Unlike here [within the HBCU context], in White STEM places it's always a competition". Throughout our analysis, we focused on how they recognized stereotypes through societal cues, cultural narratives, or personal experiences, specifically associated with African Americans in STEM fields. Ultimately, we delved into how cognitive processing guided their perception of these stereotypes in alignment with their self-concept, interests, and aspirations in STEM.

Recognizing the diverse STEM contexts African American students navigate at HBCUs, we employed PVEST to grasp their experiences within multifaceted environments. PVEST, emphasizing the interplay of various systems in identity formation, guided our instrument development. For the MAASI, we identified ecological systems such as family, community, mentors, educational institutions, and STEM experiential learning, informed by participants' lived experiences from focus groups and interviews. PVEST advocates a holistic view, prompting us to assess how family dynamics, community support, mentorship, and educational experiences influence STEM identity. The guidance from PVEST deepened our understanding of meaning-making processes, unveiling how STEM structures and cultural norms shape thoughts within STEM. CRT exposed racist systems in STEM education, and PVEST aided in crafting items revealing how cultural factors influence STEM identity. In line with PVEST, we integrated cultural sensitivity into our measure, considering how cultural aspects within ecological systems impact identity development. Students' perceptions of "STEM CULTURE" surfaced, describing it as competitive and individualistic in white STEM spaces and collaborative and supportive in Black STEM spaces. A sample item from the MAASI generated from the shared experiences of the STEM students at a southeastern HBCU expresses this notion of STEM CULTURE variation based on institutional context states "My classes are a break from the cut-throat environment of STEM".

Combining PVEST with CRT facilitated an exploration of how race, intersecting with other identities (gender, class, and sexuality), influences African American STEM students' experiences within their ecological systems. The MAASI Scale captures a nuanced understanding of STEM identity development by examining the interconnections of various dimensions of identity. CRT, focusing on systemic racism, unveils how institutions perpetuate inequalities in STEM. Integrating CRT

with PVEST enabled a systemic analysis of how racism manifests at various levels within STEM students' ecological systems, influencing experiences, opportunities, and outcomes. This dual framework approach allowed a profound investigation of racism's pervasive impact on STEM identity. PVEST broadens the perspective to consider factors influencing vulnerability in STEM identity development. Incorporating PVEST, the MAASI Scale identifies both risk and protective factors affecting persistence in STEM careers, crucial for understanding challenges impacting African American students in STEM.

During qualitative analysis, direct quotes formed the conceptual model illustrating how students' contexts shaped STEM identity vulnerability. MAASI includes four contextual factors guided by PVEST: 1) learning environments; 2) role models, mentors, and peers; 3) critical race consciousness; and 4) self-efficacy. STEM identity vulnerability integrated PVEST factors: 1) intrinsic motivation, 2) "prove them wrong" motivation, 3) sense of community responsibility, and 4) coping strategies (code-switching, withdrawal, "work harder," and "take up space").

The minimum number of items for each scale was developed based on expectations about the final factor. Quotes were revisited to convert them into items, ensuring evocative yet brief language aligned with participants' lived experiences. Published scales measuring similar constructs were consulted. For instance, the College Mentoring Scale and Marshall et al.'s (2016) framework of mentoring support were referenced for role models, mentors, and peers. After creating initial draft items, we conducted a pre-test, which involved selected items being subjected to cognitive interviews with students. One of the items examined during the pre-test pertained to the "prove them wrong" motivation, which was constructed based on the collective lived experiences of the participants during the focus groups. The goal was to assess the degree to which students believed that their outstanding achievements could challenge negative stereotypes about African Americans, ultimately easing their own and future students' advancement in STEM. Existing literature, including works by McGee (2016) and Smith et al. (2014), has often labeled this motivation as a maladaptive coping strategy. This notion was demonstrated through a participant who stated, "Sometimes it's really suffocating, it's suffocating having those stereotypes pushed onto me and then it's also suffocating sometimes to try to be more than them to try to constantly have to prove myself to people." In the context of the PVEST framework, this pattern of consistently agreeing with "prove them wrong" items, could have implications for African American students' STEM identity development. According to PVEST, the development of STEM identity involves cognitive processes, and individuals navigate through these processes within the broader context of their ecological systems. In this case, if students are consistently expressing agreement with "prove them wrong" items, it suggests that they may share a common motivation for high achievement in STEM. This motivation may potentially be influenced by stereotypes or by various factors within their ecological systems, such as personal aspirations, family expectations, or societal influences. For example, one of the MAASI items within the Prove Them Wrong subscale was constructed from a direct participant quote that reads "I'm motivated by the doubt that others have about being Black in STEM" while another reads "My achievement will disprove negative stereotypes about African Americans in STEM". The PVEST framework emphasizes the importance of understanding individual experiences within their ecological context. In this scenario, the consistent agreement with "prove them wrong" items might indicate a shared cognitive response within the specific context of STEM identity development. This insight and theoretical guidance helped us to realize that it is crucial to delve deeper into the specific factors within their ecological systems that contribute to this shared cognitive response and how it influences their STEM identity development.

### 3.7. Implications for educational psychology

Throughout this article, we have demonstrated how the use of White-normed statistical methods and psychometric instruments perpetuates a misunderstanding and misrepresentation of students of color in educational psychology. In response, we advocate for the adoption of critical theories, specifically CRT and PVEST, as guiding frameworks in an exploratory sequential mixed methods design for developing culturally appropriate anti-racist instruments. The appropriateness of employing CRT and PVEST lies in their ability to unveil the systemic and contextual factors influencing the experiences of students of color in educational settings. CRT provides a lens through which researchers can analyze the historical, social, political, and economic power relations that contribute to racial disparities. PVEST, as an ecological systems theory, allows for a holistic examination of individual experiences within broader ecological contexts, considering the interplay of various systems.

By integrating these critical theories into the development of anti-racist instruments, such as the MAASI, we anticipate a transformation in educational psychology research. This shift is expected to facilitate increased support for social justice and emancipatory efforts within communities of color. The resulting anti-racist psychometric scales, like the MAASI, not only enable more nuanced research within educational psychology but also contribute to the promotion of equitable pedagogical practices and programs in higher education.

Our alignment with Garcia et al. (2018) assertion underscores the importance of recognizing the need for an ontological reckoning in research approaches. This reckoning involves acknowledging and addressing the historical, social, political, and economic power relations that underlie quantitative research methods. Through the application of CRT and PVEST, we contend that this critical perspective is essential for reclaiming psychometric instruments and reshaping them to better serve the interests of educational psychology and the diverse communities it seeks to understand and support.

## CRediT authorship contribution statement

**Angela M. White:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Christy M. Byrd:** Writing – original draft, Formal analysis, Data curation. **Tanya A. Malloy:** Investigation.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## References

Bell, D. A. (1992). Racial realism. *Connecticut Law Review, 24*(2), 363–379.
Bonilla-Silva, E., & Zuberi, T. (2008). Toward a definition of white logic and white methods. In T. Zuberi, & E. Bonilla-Silva (Eds.), *White logic, white methods: Racism and methodology* (pp. 3–27). Lanham, MD: Rowman and Littlefield.
Brown, K., & Jackson, D. (2013). The history and conceptual elements of critical race theory. In M. Lynn, & D. A. Dixson (Eds.), *Handbook of critical race theory in education* (pp. 270–285). New York, NY: Routledge.
Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching, 44*(8), 1187–1218. https://doi.org/10.1002/tea.20237
Chemers, M. M., Zurbriggen, E. L., Syed, M., Goza, B. K., & Bearman, S. (2011). The role of efficacy and identity in science career commitment among underrepresented minority students. *Journal of Social Issues, 67*, 469–491. https://doi.org/10.1111/j.1540-4560.2011.01710.x
Cokley, K., & Awad, G. H. (2013). In defense of quantitative methods: Using the "master's tools" to promote social justice. *Journal for Social Action in Counseling and Psychology, 5*(2), 26–41. https://doi.org/10.33043/JSACP.5.2.26-41.
Covarrubias, A., & Velez, V. (2013). Critical race quantitative intersectionality: An anti-racist research paradigm that refuses to 'let the numbers speak for themselves'. In

M. Lynn, & D. A. Dixson (Eds.), *Handbook of critical race theory in education* (pp. 270–285). New York, NY: Routledge.
Cummings, N., & Cummings, D. (2021). Historical chronology: Examining psychology's contributions to the belief in racial hierarchy and perpetuation of inequality for people of color in the U.S. American Psychological Association. https://doi.org/10.1037/0000212-000.
Cunningham, M., Phillips Swanson, D., Youngblood, J., II, Seaton, E., Francois, S., & Ashford, C. (2023). Spencer's phenomenological variant of ecological systems theory (PVEST): Charting its origin and impact. *American Psychologist, 78*(4), Article 524–534.https://doi.org/10.1037/amp0001065.
Crenshaw, K. (1991). Mapping the margins: Intersectionality, identity politics, and violence against women of color. *Stanford Law Review, 43*(6), 1241–1299. https://doi.org/10.2307/1229039
Crenshaw, K. (2011). Twenty years of critical race theory: Looking back to move forward. *Connecticut Law Review, 43*(5), 1253–1352.
Creswell, J. W., & Clark, P. (2011). *Designing and conducting mixed methods research* (2nd ed.). Thousand Oaks, CA: Sage Publications.
Creswell, J. W., & Plano-Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). Los Angeles, CA: Sage.
DeCuir-Gunby, J. T., & Walker-DeVose, D. (2013). Expanding the counterstory: The potential for critical race mixed methods studies in education. In M. Lynn, & D. A. Dixson (Eds.), *Handbook of critical race theory in education* (pp. 248–259). New York, NY: Routledge.
Delgado, R., & Stefancic, J. (Eds.). (2005). *The Derrick Bell Reader*. New York, NY: NYU Press.
Delgado, R., Stefancic, J., & Harris, A. (2012). *Critical race theory: An introduction* (2nd ed.). New York, NY: NYU Press.
Delgado, R., Stefancic, J., & Harris, A. (2013). Discerning critical moments. In M. Lynn, & D. A. Dixson (Eds.), *Handbook of critical race theory in education* (pp. 23–33). New York, NY: Routledge.
Fetters, M. D., Curry, L. A., & Creswell, J. W. (2013). Achieving integration in mixed methods designs-Principles and practices. *Health Services Research, 48*(6 Pt 2), 2134–2156. https://doi.org/10.1111/1475-6773.12117
Freeman, A. (1978). Legitimizing racial discrimination through anti-discrimination law: A critical review of Supreme Court doctrine. *Minnesota Law Review, 62*, 1049–1120.
Garcia, M. N., López, N., & Vélez, V. N. (2018). QuantCrit: Rectifying quantitative methods through critical race theory. *Race Ethnicity and Education, 21*(2), 149–157. https://doi.org/10.1080/13613324.2017.1377675
Gillborn, D., Warmington, P., & Demack, S. (2018). QuantCrit: Education, policy, 'Big Data', and principles for a critical race theory of statistics. *Race Ethnicity and Education, 21*(2), 158–179. https://doi.org/10.1080/13613324.2017.1377417
Harris, C. L. (1993). Whiteness as property. *Harvard Law Review, 106*(8), 1707–1791. https://doi.org/10.2307/1341787
Harris, C. (1995). Whiteness as Property. In K. Crenshaw, N. Gotanda, G. Peller, & K. Thomas (Eds.), *Critical race theory: The key writings that formed the movement* (pp. 276–291). New York: The New Press.
Hazari, Z., Sadler, P. M., & Sonnert, G. (2013). The science identity of college students: Exploring the intersection of gender, race, and ethnicity. *Journal of College Science Teaching, 42*(5), 82–91. http://www.jstor.org/stable/43631586.
Hill Collins, P. (1998). *Fighting words: Black women and the search for justice*. Minneapolis, MN: University of Minnesota Press.
Hill Collins, P. (2000). *Black feminist thought: Knowledge, consciousness, and the politics of empowerment* (2nd ed.). New York, NY: Routledge.
Ivankova, N. V., Creswell, J. W., & Stick, S. (2006). Using mixed-methods sequential explanatory design: From theory to practice. *Field Methods, 18*(1), 3–20. https://doi.org/10.1177/1525822X05282260
Knight, G. P., Roosa, M. W., & Umaña-Taylor, A. J. (2009). Studying ethnic minority and economically disadvantaged populations: Methodological challenges and best practices. Washington, DC: American Psychological Association. https://doi.org/10.1037/11887-000.
Knowles, R. T., & Hawkman, A. M. (2020). Anti-racist quantitative research: Developing, validating, and implementing racialized teaching efficacy and racial fragility scales. *The Urban Review, 52*(2), 238–262. https://doi.org/10.1007/s11256-019-00526-1
Kumar, R., & DeCuir-Gunby, J. (2023). What is the role of race in educational psychology? A review of research in Educational Psychologist. *Educational Psychologist, 58*(1), 1–17. https://doi.org/10.1080/00461520.2022.2137804
Kumar, R., Hany, S., & Dagostino-Kalniz, V. (in press). Culturalizing and animating educational psychology: A translational theory-to-practice paradigm. In J.Smith & A. Johnson (Eds). Teaching to prepare advocates. Routledge.
Ladson-Billings, G. J., & Tate, W. F. (1995). Toward a critical race theory of education. *Teachers College Press, 97*, 47–68. https://doi.org/10.1177/0161468195097001
Ladson-Billings, G. J. (2013). Critical race theory – What it is not! In M. Lynn, & D. A. Dixson (Eds.), *Handbook of critical race theory in education* (pp. 34–47). New York, NY: Routledge.
Lynn, M., & Dixson, A. D. (2013). *Handbook of critical race theory in education*. New York: Routledge.
Matsuda, M. J. (1987). Looking to the bottom: Critical legal studies and reparations. *Harvard Civil Rights-Civil Liberties Law Review, 22*, 323–399.
Matsuda, M. (1995). Looking to the bottom: Critical legal studies and reparations. In K. Crenshaw, N. Gotanda, G. Peller, & K. Thomas (Eds.), *Critical race theory: The key writings that formed the movement* (pp. 63–79). New York, NY: The New Press.
McGee, E. O. (2016). Devalued Black and Latino racial identities: A by-product of STEM college culture? *American Educational Research Journal, 53*(6), 1626–1662. https://doi.org/10.3102/0002831216676572
O'Cathain, A. E., Murphy, A. E., & Nicholl, J. (2010). Three techniques for integrating data in mixed methods studies. *British Medical Journal, 341*, Article c4587. https://doi.org/10.1136/bmj.c4587
Onwuegbuzie, A. J., Bustamante, R. M., & Nelson, J. A. (2010). Mixed research as a research tool for developing quantitative instruments. *Journal of Mixed Methods Research, 4*(1), 56–78. https://doi.org/10.1177/1558689809355805
Pajares, F. (2007). Culturalizing educational psychology. In F. Salili, & R. Hoosain (Eds.), *Culture, motivation, and learning: A multicultural perspective*. IAP: Charlotte, NC.
Parker, L. (2015). Critical race theory in education and qualitative inquiry: What each has to offer each other now? *Qualitative Inquiry, 21*(3), 199–205. https://doi.org/10.1177/1077800414557828
Reeves, R. V., & Halikias, D. (2017). *Race gaps in SAT scores highlight inequality and hinder upward mobility*. Washington, DC: Brookings Institution. https://www.brookings.edu/research/race-gaps-in-sat-scores-highlight-inequality-and-hinder-upward-mobility/.
Reynolds, C. R., Altmann, R. A., & Allen, D. N. (2021). The problem of bias in psychological assessment. In C. R. Reynolds, R. A. Altmann, & D. N. Allen (Eds.), *Mastering modern psychological testing: Theory and methods* (pp. 573–613). Springer International Publishing. https://doi.org/10.1007/978-3-030-59455-8_15.
Sablan, J. R. (2019). Can you really measure that? Combining critical race theory and quantitative methods. *American Educational Research Journal, 56*(1), 178–203. https://doi.org/10.3102/0002831218798325
Spencer, M. B. (2006). Phenomenology and ecological systems theory: Development of diverse groups. In R. M. Lerner, & W. Damon (Eds.), *Handbook of child psychology: Theoretical models of human development* (pp. 829–893). John Wiley & Sons.
Spencer, M. B. (2021). Acknowledging bias and pursuing protections to support anti-racist developmental science: Critical contributions of phenomenological variant of ecological systems theory. *Journal of Adolescent Research, 36*(6), 569–583. https://doi.org/10.1177/07435584211045
Strunk, K. K., & Andrzejewski, C. E. (2023). Racisms of commission and omission in educational psychology: A historical analysis and systematic review. *Educational Psychologist, 58*(1), 1–13. https://doi.org/10.1080/00461520.2022.2152031
Tabron, L. A., & Thomas, A. K. (2023). Deeper than Wordplay: A Systematic Review of Critical Quantitative Approaches in Education Research (2007–2021). *Review of Educational Research, 93*(5), 756–786. https://doi.org/10.3102/00346543221130017
Usher, E. L. (2018). Acknowledging the whiteness of motivation research: Seeking cultural relevance. *Educational Psychologist, 53*(2), 131–144. https://doi.org/10.1080/00461520.2018.1442220
Westmarland, N. (2001). The quantitative/qualitative debate and feminist research: A subjective view of objectivity. Forum: Qualitative. *Social Research, 2*(1). https://doi.org/10.17169/fqs-2.1.974.
White, A. M., DeCuir-Gunby, J. T., & Kim, S. (2019). A mixed methods exploration of the relationships between the racial identity, science identity, science self-efficacy, and science achievement of African American students at HBCUs. *Contemporary Educational Psychology, 57*, 54–71. https://doi.org/10.1016/j.cedpsych.2018.11.006
Younas, A., Rasheed, S. P., Zeb, H., & Inayat, S. (2020). Data integration using the building technique in mixed-methods instrument development: Methodological discussion. *Journal of Advanced Nursing, 76*(8), 2198–2207. https://doi.org/10.1111/jan.14415
Zhou, Y. (2019). A mixed methods model of scale development and validation analysis. *Measurement: Interdisciplinary Research and Perspectives, 17*(1), 38–47. https://doi.org/10.1080/15366367.2018.1479088
Zuberi, T., & Bonilla-Silva, E. (Eds.). (2008). *White logic, white methods: Racism and methodology*. Lanham, MD: Rowman & Littlefield.
Zusho, A., & Clayton, K. (2011). Culturalizing achievement goal theory and research. *Educational Psychologist, 46*(4), Article 239–260.https://doi.org/10.1080/00461520.2011.614526.