A Model for Redefining STEM Identity For Talented STEM Graduate Students

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Introduction

As researchers continue to search for ways to inform recruitment and retention of underrepresented racial minorities (URM) in science, technology, engineering, and mathematics (STEM), there has been increasing attention on examining how students identify with these disciplines. STEM fields are highly appealing to URM students, as their proportionate initial interests in STEM are nearly identical (approx. 34%) to the interests of their White and Asian American peers (HERI, 2010). Unfortunately, many of the URM students who enter STEM do complete their degrees and thus, we see an underrepresentation in STEM graduate programs, the professoriate, and in STEM careers (HERI, 2010).

STEM persistence is dependent not only on students' motivation and interest, but is also associated with their ability to identify with STEM and STEM careers (Carlone & Johnson, 2007). Even those who are competent and have achieved in STEM, may struggle to identify with STEM if they cannot find connections to their lives and goals (Kozoll & Osborne, 2004). As other scholars have posited (Brickhouse et al. 2000; Brown et al. 2005; Carlone & Johnson 2007; Kozoll & Osborne 2004), we feel the utilization of an identity lens offers the most complete understanding of students' pathways in relation to STEM (alienation or recruitment). Hence, there is much to learn from the STEM identity trajectories of successful URM students that have navigated STEM degree programs to completion.

Purpose

This paper seeks to further operationalize the concept of STEM identity as a theoretical frame to provide methodological and analytical direction for future research. To do this we will review the various contributions to the literature in STEM education, which have utilize the construct of identity and draw from various research perspectives (Brickhouse et al. 2000; Brown et al. 2005; Carlone & Johnson 2007; Kozoll & Osborne 2004). Focusing on identity as interactionist by nature, we draw from Carlone & Johnson's (2007) original conception of science identity to further expand upon the intersectionality of identity, which operates within various social contexts and structures. It is the interactions between individuals and meaningful communities or groups that has not been fully detailed in the current literature on science identity. We propose these interactions as reciprocal or two-way interactions that are opportunities for recognition. Outlining the various types and possibilities for recognition allows for a more complete understanding of how we can redefine STEM by expanding talent identification and illuminated the value of diverse perspectives in advancing STEM fields.

Theory Grounded in Empirical Findings

As a scholarly paper, the bulk of what we present will focus on describing the theoretical concepts that are set forth in the proposed framework. These concepts are however, guided and grounded in qualitative findings from a large national research study. Data are drawn from over 60 hours of focus group interviews with a racially diverse group of 132 masters or doctoral students from seven universities across the United States. In presenting qualitative findings, we will focus on data collected from the 84 students in the sample who identified as URM students, specifically defined as African American, American Indian, and Latino. The campus sites included three Hispanic serving institutions (HSI), one historically Black college/university (HBCU), and three predominantly White institutions (PWI). A semi-structured interview technique was used (Merriam, 1998), and all focus group interviews were audio recorded, professionally transcribed and checked for accuracy. A team of six researchers read transcripts and identified emergent themes. Through an ongoing process of review, note-taking, and memo writing, an initial coding structure was created in NVivo 8 and refined through three rounds of inter-coder reliability exercises (Creswell, 2007; Miles & Huberman, 1994), where 85% agreement was reached. We will utilize qualitative quotes to briefly demonstrate the thematic findings that emerged in our analysis as they related to the proposed theoretical concepts. For a full description of the methods and the breath of qualitative findings refer to Tran, Herrera, and Gasiewski (2011).

Identity Frameworks in STEM

As other theorists have posited, we conceptualize the enculturation into STEM and eventually entering a STEM related study or career as part of an identity-process (Christidou, 2011). While we acknowledge that using an identity lens offers the most complete understanding of students' trajectories in STEM, it is a complex theoretical concept. There have several interpretations of how the term "identity" is conceptualized in science education literature (Brubaker & Cooper, 2000; Calabrese Barton,1998; Brickhouse & Potter, 2001). The term "identity" is a complex construct commonly defined as an individuals' understanding of her or himself as a separate entity. Erikson (1968) described "identity development," as the process that all individuals experience to define their own identities.

From a traditionalist psychological perspective the 'core identity' is the result of enduring identity patterns and long-term identity development (Gee, 2000). Others describe identity as extremely personal (Wortham, 2004) as a story that we each create for ourselves (Polman & Miller, 2010). The concept of identity encompasses one's past, present and future, as well as one's ethnicities, races, religions, genders, sexual-orientation, life-histories, and current realities; therefore, indicating that people have multiple identities (Alsup, 2006, Gee, 2000). Identity can be viewed as interactionist by nature, because of the social and structural aspects that enter identity and identity formation (Gee, 2000). Despite all ambiguities, the identity construct already has proven fruitful within STEM education research, as evidenced by a sample of important contributions from various research perspectives (Brickhouse et al. 2000; Brown et al. 2005; Carlone & Johnson 2007; Kozoll & Osborne 2004; Malone and Barabino, 2009).

Science Identity

To strengthen our conception of STEM identity as relational through an interactionist perspective, we draw directly from Carlone and Johnson's (2007) theory of science identity. Through an explicit study of women of color in the sciences they identify three categories that define a strong science identity: 1) competence, 2) performance, and 3) recognition. Individuals need to be competent or able to demonstrate skills and science knowledge. This "competence" is delivered through their performance in varying contexts. And finally this "performance" needs to be "recognized" as a science person by meaningful others. All three of these components can be affected by race, ethnicity, and gender.

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Carlone and Johnson's (2007) posit that a student must recognize them self as a scientist, as well as be recognized by others as legitimate a science person; therefore, their conception of science identity is dependent on social interaction. Learning operates with in social interaction; students must demonstrate their competence; and their performance must be positively recognized by meaningful, credible members of the STEM community. In their study, science persistence came from students' ability to identify with science and science careers, and they characterized their participants' science identities through three categories: research scientist, altruistic scientist, and disrupted scientist.

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Drawing from this well-developed framework of science identity and our study findings, we propose a model for redefining STEM through identity (see Figure 2.). Through this model we will expand upon the meaning of identity development across STEM disciplines and among the intersections of multiple identities. Additionally, Carlone and Johnson (2007) sought to consider "the complex interplay of structure and agency". We take a unique stance on the impact of societal, disciplinary, and other social structures on the STEM identity development of URM students. Finally, we will elaborate on the opportunities for recognition as a way to redefine talent identification and development in STEM fields.

Intersectionality of Multiple Identities

We begin to construct STEM identity by acknowledging the multiple social identities that students possess. Jones & McEwen (2000) conceptualized intersecting identity dimensions (e.g., race, sexual orientation, and religion) as situated around one's core identity or sense of self. In this model, identity dimensions intersect with one another to demonstrate that no one dimension may be understood singularly, but is defined in relation to other dimensions (Jones & McEwen, 2000). The importance or relative salience of particular identities is unique to each individual (Nasir & Saxe, 2003).

Scholars have noted that when asked to describe oneself, an individual often does not include aspects of self that are consistent with the dominant culture (Tatum, 1997). Therefore, it is important to consider how power relates to identity, social practices, institutional arrangements, and cultural ideologies (Davis, 2008).

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Utilizing an ‘intersectionality’ lens (Crenshaw, 1989) to examine underrepresented racial minorities in STEM, allows us to consider the power dynamics for understanding structural oppression and multiple inequalities (Choo & Ferree, 2010). By allowing for a dynamic relationship between people’s social identities, we can examine both the individual and institutional levels of inequality (Choo & Ferree, 2010; Hancock, 2007). We can identify where individuals sit at the crossroads of various oppressed identities and acknowledge the power that is present within social structures (Yuval-Davis, 2006). Power continually operates within societal structures as inequalities are both imbedded in, and act to transform structures at all levels and in all institutional contexts (Davis, 2008).

Contexts, Structures, and Group/Community Identification

Drawing from these intersectional approaches we gain an understanding of how identity operates within contexts and structures. Identity is developed and enacted in multiple contexts (Jones & McEwen, 2000). In our STEM identity model (see Figure 2), explicitly highlight three contexts—*societal contexts, non-STEM contexts*, and *STEM contexts*. Structures are imbedded within context as an ‘intersectionality’ lens illuminates the structural power dynamics that are present within specific contexts (Crenshaw, 1989). To be clear, we define structure as the underlying patterns, expectations, and norms that influence relationships and behavior within social groups (Sewell, 1992; Shanahan & Nieswandt, 2012). Structure is not external or static, but is socially constructed and continually produced and reproduced by individuals and their interactions with each other (Shanahan & Nieswandt, 2012). Cote and Levine's (2002) conception of social structure describes the patterns that characterize, facilitate and constrain groups and societies, including social norms, social roles, and the conformity pressures that individuals may experience within these groups.

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Within a *societal context*, as proposed in the STEM identity framework, social structures can be viewed broadly as we proposed through the use of intersectionality to refer to the embedded inequalities assumed in analyses related to race, gender, and class (Crenshaw, 1989). As it relates to STEM, the underrepresentation of racial minorities is reflective of the power dynamics and social inequalities that are perpetuated through the overarching social structures. For example structural inequalities are evident within the societal structure of the United States as African American, American Indian, and Latino students frequently attend K-12 schools with fewer resources and, thus, fewer opportunities to develop the solid academic base necessary for a science career (Cooper & Burciaga, 2011, Lee & Orfield, 2007). Therefore it is important to consider how the STEM identity trajectories of URM students are affected by "institutional arrangements and power relations" (Wortham, 2006, p. 105).

In honing in from the broad societal context to more narrowly defined contexts, we need to consider the contexts in which specific groups and communities are indexed to particular social structures. Any social group or social space may have a social structure, which has “expectations and norms required for participation” (Shanahan & Nieswandt, 2012). Therefore, in our model we elaborate on both *non-STEM and STEM contexts* as spaces where specific groups and communities operate within structural constraints and opportunities.

By broadly defining *non-STEM contexts* in our STEM identity model, we recognizing that are many group and community contexts that individuals identify with outside of STEM. Perhaps one of the most salient non-STEM contexts in our discussion of URM students is the racial/ethic community context, which we focus on in the model. We must consider the social, cultural, and historical backgrounds of these groups in terms of inequalities and oppression, as suggested through intersectionality (Crenshaw, 1989). It is equality important to validate and recognize the accumulated assets and resources in the histories and lives of racial/ethnic communities (Yosso, 2005). Several scholars have identified and described various forms of knowledge, skills, abilities and networks that underrepresented racial minority students bring with them from their homes and communities (Yosso, 2005). There is value in and much to learn and draw from in the cultural and social assets of racial/ethnic communities.

While ethnic/racial communities have been marginalized in the U.S. societal context and structures, STEM contexts have held in much regard as high-status arenas (Johnson, Brown, Carlone, & Cervas, 2011). We specify *STEM contexts* rather than science contexts to provide an analytical lens that is flexible in examining the specific norms associated with various STEM disciplines (i.e. engineering, math). The social structure embedded in STEM contexts centers around the enduring and historically constructed meanings associated STEM disciplines. Within the contexts of the dominant

Western society, specific forms of knowledge, skills and abilities that are valued and socioculutral boundaries dictate membership into privileged STEM communities (Ong, 2005). These fields are often identified in the broader sociohistorical frames through predominantly white, masculine, and heteronormative features (Harding, 1998; Carlone & Johnson, 2007; Johnson, 2006; Ong, 2005).

STEM disciplines have traditionally represented as an intellectually objective and a pure form of logical processing (Cobb, 2004). Thus, perpetuating "the myth that STEM education must be divorced from everyday knowledge, situational concerns, human interests, social conventions, and other aspects of students' lives" (Tran, et al., 2011, p. 3). This dominant disciplinary culture generally dictates STEM related teaching, learning, and practice; therefore, the structural elements within STEM context can promote dominant groups while marginalizing minority identities (Cobb, 2004).

Interaction as Opportunities for Recognition

Thus, far we have discussed how social structure can constrain or support underrepresented racial minority students in developing STEM identities. Defining identity as dependent on interaction, we view STEM identity development as both a refection of how one perceives and positions and aligns oneself within STEM, and how they are perceived and recognized by meaningful others (Carlone & Johnson, 2007). Therefore, student's agency in the identity development process must be acknowledged. Students have the ability to act intentionally against social structures in constructing a STEM identity (Shanahan, 2009). This is where our examination of *successful* URM graduate students is critical in understanding role of recognition. Carlone & Johnson's (2007) model highlighted *competence* in science identity development. Clearly URM students who have made it to the highest levels of STEM education possess field specific *competence*. In addition, they have successfully navigated through the STEM disciplinary trajectory; therefore, have been effective in ‘*performances*’ of the disciplinary discourse and practices. Through their quotes we elucidate the ways in which they have been recognized or not recognized; how they seek to be recognized; and this impacts their STEM identity development.

Carlone & Johnson’s (2007) defined three sources of recognition self-recognition and external recognition from meaningful other within and outside of STEM. In addition they highlighted several types of recognition that were either positive or negative. Findings from our qualitative data confirmed these sources and types of recognition. From a more critical perspective we demonstrate the types of opportunities for recognition that are missed as focus on the way successful students have self-recognized their contribution to STEM disciplines, which are not always acknowledged within STEM communities.

Recognition from STEM Community Members

As demonstrated through the theoretical model, strong identity development is in part a reflection of how one perceives established group/community member’s recognition of him or her (Erikson, 1968). Student’s interactions with others in STEM (i.e. faculty, post-docs, lab partners, and student) are part of the socialization process. Positive recognition reinforces their STEM identities while negative recognition can constrain their STEM identity development.

Positive recognition. Considering that identity is fluid and continuously changing (Gee, 2000), repeated or continuous recognition was noted among many URM students as a key factor in their motivation.

> Interacting with others affects how I feel as a scientist and reaffirms my identity as a scientist. If I'm in the lab making sorts of things, that gives me the drive or motivation to be a scientist. (Maria, African American, Biomedical Engineering)

While recognition came from many different types of STEM community members, students described it to be most reaffirming when it was received from those who they considered authorities in the field.

> We have a good relationship because [my advisor] wanted to really stress and encourage the idea that at this point in time we were peers, so like I need to talk to him like he's another scientist and he'll talk to me like I'm another scientist. (Ella, African American, Biochemistry/Biophysics)

Negative recognition. As students at the margins of STEM fields their bids for recognition as legitimate STEM researchers they are often unrecognized. Carlone and Johnson (2007) found that recognition was the area where the science status quo was reproduced. Participants believed that individuals in their departments promoted or supported individuals who talked, looked, and acted like the "historical and prototypical notions of scientist" (Carlone & Johnson, p 1207). URM students, and particularly URM women, felt out of place and noted the isolation.

> So, [engineering] is really dominated by older, white men. That was probably the most difficult in terms of my age, my race, my gender, all of those things kind of made life a little bit difficult. – Chloe (African American Female, Chemical Engineering)

Students' ability to imagine a future in STEM or construct a STEM identity is hindered considerably by the very small number of URM professors in STEM fields (Gandara & Maxwell-Jolley, 1999). Operating within historically white, male dominated STEM contexts, many URM students also found themselves not being recognized as legitimate STEM community member, but in terms of negative stereotypes.

> But like race is a big one just because you just don't see a lot of African Americans in engineering or anything like the STEM fields. And it's kind of a conflict because, you know there's, you know even within the academy itself, you know there's people who kind of question, you know your ability. I always feel the need to kind of work harder and outperform, you know other people because like I'm aware of the fact that there are some people who question am I supposed to be here, can I really measure up. – Sean (African American Male, Engineering)

Through these interactions, unwanted identities are being ascribed to the student based on their stigmatized social identities. Students may become disconnected from STEM if they do not feel that they can be recognized beyond these stereotypical notions. Negative recognition from others can affect one's ability to be recognized as a legitimate STEM community member.

STEM Self-recognition

Students describe in varying degrees how they recognized themselves as a legitimate person in STEM: Whether it was their interest in studying the natural world, employing logical reasoning, or generally connecting to the discipline.

> I think science is definitely a big part of my life and it's a big part of who I am, just because it's more of a way of thinking. I think you see things in a different way than maybe other people do, and you analyze things and you want to know why things work the way they do and how they work. (Allison, Latina, Chemical Engineering)

Self-recognition of one's STEM identity was not purely defined in terms of their competence or their ability to perform or carry out disciplinary practices. Students recognized their identification with STEM as a force that was embedded into their everyday life and their sense of self. This holistic way of viewing identity suggests that

STEM identity develop is not solely encompassed within interactions through STEM contexts, but perhaps within other contexts.

STEM Recognition in Relation to Racial/Ethnic Identities and Communities

There are multiple contexts within which identity is developed and enacted (Syed, 2011). Student's STEM identities are developing while they are interacting within non-STEM contexts. The majority of the URM students in our sample described a connection between their interests in STEM and their racial/ethnic backgrounds or communities. In many cases, their STEM identities were being cultivating in these non-STEM contexts before they were formal exposed to STEM through education.

> I think I became interested in science just as a way to understand my surroundings. I grew up on an Indian reservation so I saw a lot of death and a lot of disease and things like that going on when I was growing up. My interest was, like I said, was to understand my environment and try to get a feel for the underlying causes of the things I was seeing. (Carson, American Indian, Bioinformatics)

In many cases, students described these early connections as continuing to inform their future work in STEM. Additionally, many of these connections were linked to altruistic intentions that informed how students envisioned their place in STEM.

> "I've been cultivating this [science] identity, since I was 12. I always wanted to make a difference. Through my experience in science, as an organic chemist, I can contribute to a medicine cure." (Aaron, African American, Biological Chemistry)

Connections to racial/ethnic identities and communities were salient in how students identified themselves and envisioned their work in STEM. Remembering that identity is influenced by how one conceives their identity as recognized by meaningful others (Carlone & Johnson, 2007), we can infer the benefits to STEM identity development if these connections to racial/ethnic identities and communities were recognized and valued among STEM community members.

Redefining Disciplines through STEM Identity Recognition

As indicated by the findings, the aspects that students see central to self-recognition of their STEM identities are not always the same attributes that are valued and recognized by STEM community members. Unfortunately, we know that many students leave STEM for majors in the humanities and social sciences, because they tend to address issues of culture, ethnicity, and diversity (Syed, 2011). With the status quo continuing to be recognized as the sole legitimate paradigm within STEM contexts, will URM students who conceptualize their STEM identities to be connected to broader communities contexts continue to leave STEM due to lack recognition? What opportunities within STEM fields are missed when talented URM students are excluded from recognition in STEM? These questions and the students' descriptions led us to seek a framework for critically examining STEM identity development through recognition. In our proposed model we seek not just to describe the status quo, but to provide a critical perspective on what might or should be (Cote, 2006). Many students point to the unique goals or pursuits that they have envisioned within STEM.

> And I think it's quite interesting that I identify myself as a scientist or someone who has a science background and I have an opportunity now to do something that I actually work with people and look at poverty reduction and issues of electricity when it comes to poverty reduction. So I get to actually do something I feel that's meaningful in everyday. (Brandon, African American, Applied Physics)

We conceptualize the possibilities for redefining STEM disciplines through alignment of how STEM identity is defined and recognized and by promoting more interaction among STEM communities and marginalized racial communities.

Recognition of Talent

The historical and prototypical notions embedded in what is associated with what a STEM authority should look, talk and act like, influence how STEM community members initially look for talent among entering students (Carlone & Johnson, 2007). URM students often face many barriers early on in their educational pursuits as they often sit at the intersections of several oppressed identities (i.e. racial minority females). Several students describe how historical inequities limited their access to educational opportunities.

> I came from a very low-income family so the kind of resources I have available to me and throughout college and even now is very different from that of other people and that's always been very salient to me. It's just the different sorts of resources I had available to me and the kinds of things I reference. This taught me to take full advantage of every resource that I could get my hands on. (Sophia, Latina, Epidemiology)

> I think it wasn't until high school that I took a biology course, and I really loved biology; it was my favorite course. But at that point I still didn't have the confidence to think I could do science. So it took me having to wait until I was older and just saying, "I like it, and I'm going to do it". One of my goals now is to work with minority students to try to lift them up at a teaching capacity so they don't have to feel like I did, like, "Wow, I don't belong here". (Lillian, Latina, Biomedical Science)

These students' quotes provide insights into redefining how we look for talent among URM students. Scholars have pointed to the aspiration capital of minority students in being able to maintain hope and persevere in the face of structural inequities (Yosso, 2005). This resilience or resourcefulness required these students to continuously look for new solutions. One might argue that these "invisible strategies" (Tierney & Auerbach, 2006), are evident in how these students approach science. For example, students with genuine interest in STEM, like Lillian, may persevere to succeed in their field despite initially lacking confidence or academic preparedness. Or like Sophia, a student may be accustomed to having to think more broadly about the questions they ask or in the areas of scholarship that they employ in seeking answers to scientific questions. Student might demonstrate these skills through significant progress in class assignments (relative to where they initially started) or by asking good questions in scholarly discussions, yet might not be recognized by STEM faculty who are focused solely on grades. In an increasingly diverse and complex world, this ability to draw from a variety of resources may position these students to contribute to the advancement of their field in a way that may not have been considered within these narrowly defined disciplines. More exploration is needed to fully elucidate how students' backgrounds may be viewed as strengths and assets to STEM disciplines rather than deficits (Chavez, 2008). However, this raised questions as to how we might re-conceptualize identifying and developing talent among URM students in STEM.

Recognition of Racial/Ethnic Community Cultural Knowledge

STEM knowledge building is "often depicted as monolithic and as involving the disembodied voice of objectivism and rationality" (Cobb, 2004). This perpetuates the myth that STEM education must be divorced from everyday knowledge, situational concerns, human interests, social conventions, and other aspects of students' lives. The rich cultural knowledge, skills, abilities, and networks possessed by URM students are often ignored in STEM curriculum and scholarship.

> I would talk to my professors about things, like Black history. Like "Don't skip over that page about Ernest Everett Just in the book. That's in the book. Let's read about this. I want to know…why can't other students know about what he did? – (Kaelyn, African American, Biology)

Cultural knowledge can be viewed as a currency the students use to make meaning (Yosso, 2005; Chigeza, 2010), which can help to connect their social identities with their STEM identities. Kaelyn is aware that the inclusion of the significant contributions African Americans in the sciences is critical, not just for her own identity related needs, but for the benefit of all students in the classroom. Exclusion of cultural knowledge in the curriculum is one way that STEM social structures reinforce the normative and institutional views of "when science occurs" (Zimmerman, 2012). In others words, we are referring to the recognition of racial/ethnic communities as contexts where science occurs and where STEM learning experiences can be situated. Here, Mason describes his family's cultural knowledge in farming as valid scientific knowledge.

> I was raised in a small farming community. So my family has always had the same interest in agriculture. They have farmer's knowledge from what their parents taught them and what their parents taught them…that has a strong background in sciences (Mason, Latino, Environmental Science)

Integrating non-Western perspectives and the different ways of knowing used around the world into STEM disciplines, not only promotes cultural connections for underrepresented students, but can be beneficial in exposing all students to new ways of approaching scientific inquiry. In many cases these cultural resources and interests serve as springboards for how URM students approach their research.

> I did research with a Latina physician, who opened my eyes to a population-based approach to health as opposed to a one-on-one individual approach. I enjoyed her approach to problems that I sort of grew up with on the border in terms of environmental health conditions. That's what inspires me. (Jackson, Latino, Public Health)

Jackson is inspired by the culturally specific approach of his mentor and the close interaction between her racial/ethnic identity and her STEM related work. As Jackson seeks to pursue his own culturally informed STEM work, it will be essential for his cultural knowledge to be recognized within the STEM community. Clearly the benefits of recognizing the URM cultural knowledge are not just beneficial to the student, but advance STEM fields overall as these students' cultural worldviews inform and create scholarship that might not otherwise be considered.

Recognition of Racial/Ethnic Community Networks

In many ways STEM contexts have continued to operate in isolation without fully exploring the possibilities for interactions with diverse communities. One asset that URM students bring with them is the broad cultural networks of their racial/ethnic communities. As we have noted, these students often seek to bridge the connection between their heritage communities and the STEM community.

> My first advisor actually was pretty awful, but now I have a good advisor that's invested in my [participation] – in the things that are important to me like teaching Indian students and going to these conferences to meet other Indian people and network so I can get a job teaching and working in science with Indians (Carson, American Indian, Bioinformatics)

Carson discussed in detail the hardships he faced with an unsupportive advisor, which almost led to his leaving the sciences. It is essential for URM students who pursue community related research to obtain recognition of the pursuits as legitimate from STEM communities members, as it is often central to how they envision the development of their STEM identities. Through these interactions between STEM communities and racial/ethnic communities, important connections and collaborations can be forged. With the growing empirical evidence highlighting the value of community participatory research and its ability to inform science, particularly in health science (Smedley &

Mittmain, 2011), STEM authorities must recognize the potential for advancing their research and promoting larger social justice agendas.

Discussion & Conclusion

Through our qualitative findings from successful URM graduate students in STEM, we developed a model for redefining STEM through identity. We expanded upon Carlone & Johnson (2007) science identity model in several ways. First, we sought a more flexible framework that could be applied to all STEM fields in acknowledging discipline specific norms, practices, and identities (i.e. Math Identity, Engineering Identity). Second, we drew from an intersectionality lens to allow researchers to think more broadly about the multiple social identities that influences one's position within STEM. Third, we elaborated on the multiple contexts through which STEM identity is developed and recognized. We outlined the structures inherent within the broader *societal context* and *racial/ethnic* and *STEM contexts* and the social groups or communities that assign membership. Lastly, we proposed ways to further support URM students' STEM identities by redefining what is recognized a legitimate within the field. This redefinition promotes equity in STEM, provides new perspectives on recognizing talent, and opens up possibilities for advancement of STEM fields. Diverse perspectives can expand knowledge and advance STEM fields in new ways; therefore, our model provides a framework for more interaction between racial/ethnic communities and STEM communities.

Redefining STEM has meaning in several different areas and can provide practical implications for how URM students are recognized in STEM. Recognizing talent in new ways involves acknowledging the historically oppressive contexts that shape opportunities for URM students. Recognizing the value in cultural knowledge, skills, abilities, and networks promotes students ability to successfully connect their social identities and STEM identity. STEM faculty can do this by making students aware of significant ethnic minority figures in the field, surfacing the historical and cultural context in which STEM research is situated, and highlighting different ways of knowing used around the world. Furthermore, URM students can provide a link between STEM and their heritage communities, which can lead to fruitful collaborations with racial/ethnic communities to produce in-depth participatory research in STEM.

Redefining STEM provides us a new way to promote efforts to increase representation among racial minority students. The recognition of URM students' unique contributions to STEM and the links between their social identities and STEM identities can promote recruitment and retention efforts. Additionally, this framing allows us to illuminate the prospective benefits for all students when connections are made between STEM and cultural communities. This interaction holds great potential for advancing STEM research and promoting more social conscious endeavors in STEM.

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Figure 1. Science Identity

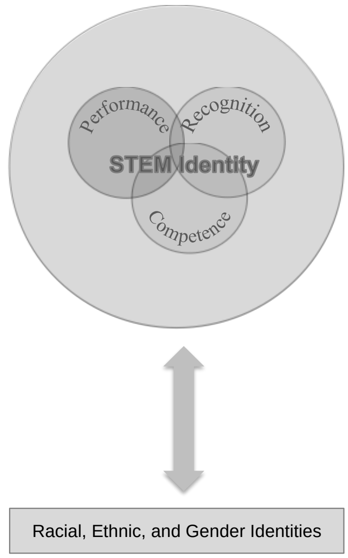

Figure 1. Model of science identity. Adapted from "Understanding the science experiences of successful women of color: Science identity as an analytic lens" by H. B. Carlone & A. Johnson, 2007, Journal of Research in Science Teaching, 44(8), p. 1191., Copyright 2007 by Wiley InterScience.

Figure 2. Model for Redefining STEM through Identity

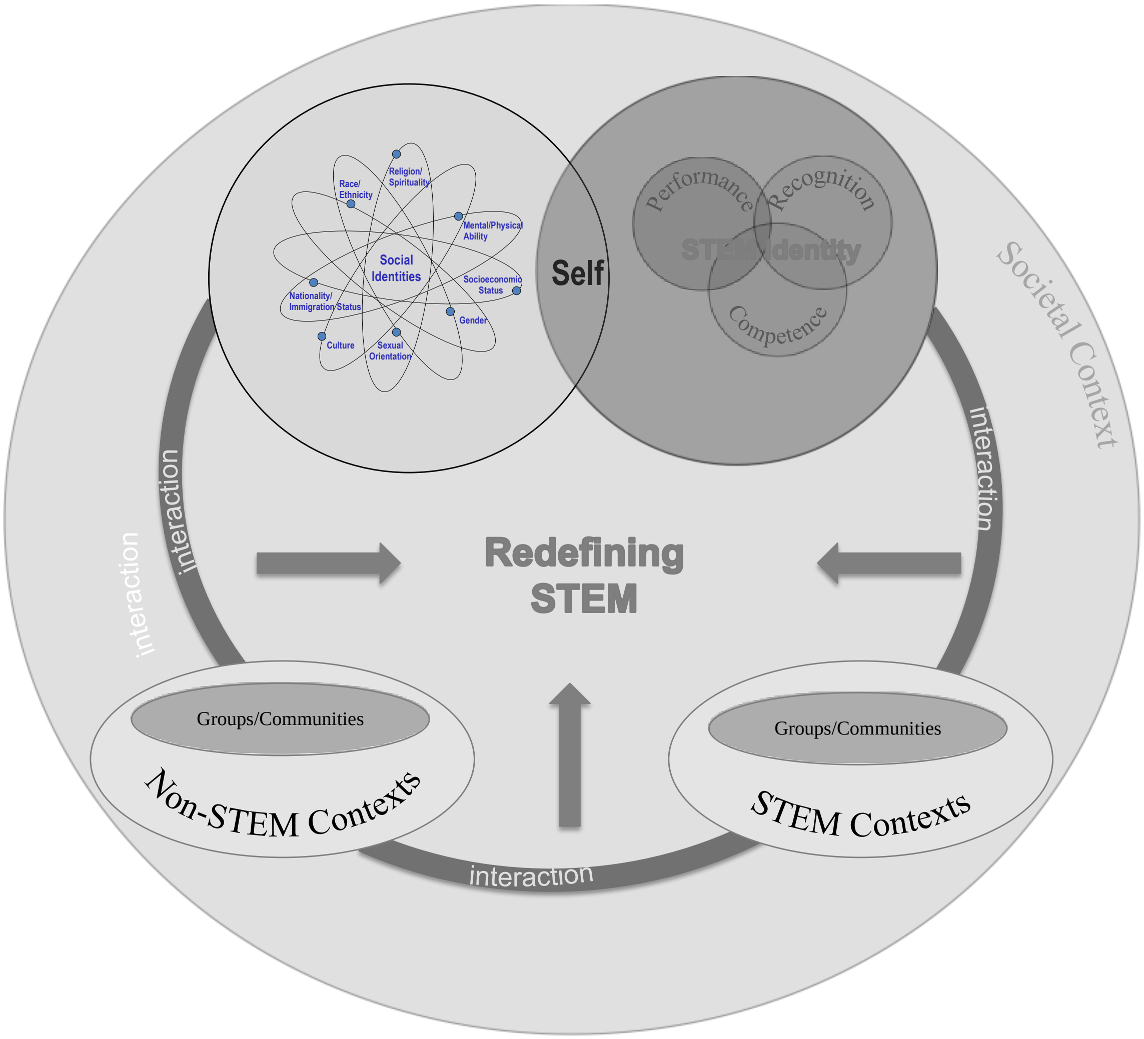

Figure 2. Theoretical model informed by science identity frameworks and empirical findings

Figure 3. Multiple Social Identities

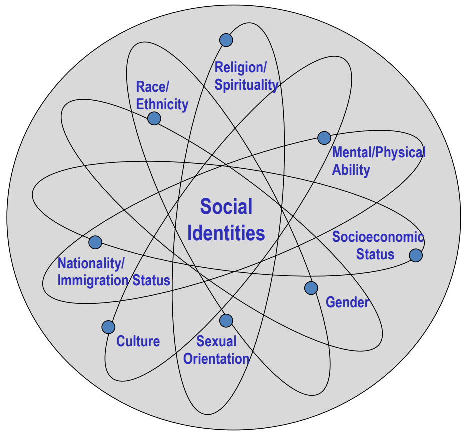

Figure 3. Model of multiple social identities. Adapted from “, (2000). A conceptual model of multiple dimensions of identity. Ethnic and Academic Identities: A Cultural Practice Perspective on Emerging Tensions and Their Management in the Lives of Minority Students.” by S. Jones & M. McEwen, 2000, Journal of College Student Development, 41(4), p. 15, Copyright 2003 by American College Personnel Association