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The Act of Negotiating Icky Aspects and Minority Ambitions to Pursue Post-Secondary STEM

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Abstract
The STEM pipeline is viewed as a universal metaphor representing the "path from elementary school to a STEM career" (Hill, Corbett, & Rose, 2010, p. 17). In the last few years, initiatives focused on strengthening the STEM pipeline have expanded in scale and emphases; from broadening the STEM pipeline to diversifying. In spite of multi-pronged efforts on the behalf of various entities, lower rates of participation in the STEM pipeline continue to prevail among individuals from ethnic, racial, and socio-economic groups; especially in physical sciences and engineering (Jacobs & Simpkins, 2005; Kahle, 2004; National Science Foundation, 2013; President's Council of Advisors on Science and Technology, 2010, 2012; Rothwell, 2014).

Students at the intersectionality of two or more variables of underrepresentation are exponentially disadvantaged within the STEM pipeline (NCES, 2009; Sadler, et al., 2012). If we are to craft effective ways of diversifying the STEM pipeline in the US, we have to start by first exploring socio-cultural variables vis-a´-vis the proportional representation of all segments of the US population (Hill, Corbett, & Rose, 2010; McDermot & Mack, 2014). Harris-Perry (2013) discusses women of color at the intersection of race and gender as they craft their progress in juxtaposition with stereotypes as well as subtle and actual prejudice.

Historically, programs created to serve women have primarily benefitted White women and programs designed to serve minorities have mainly served minority men (Ong et al., 2011). And although, female students' participation is increasing in life and health sciences; their involvement in physical sciences, engineering, and mathematics continues to be at or near historic lows (Hill, Corbett, & Rose, 2010; Rankins, Rankins & Inniss, 2014; Rothwell, 2014).

Within the above context, this study explores the journeys and issues of concern/ambiguity of minority female students through last two years of high school into matriculation in postsecondary STEM degrees/majors. The students are enrolled in two high schools located in a starkly under resourced area. The study hypothesizes that the challenges experienced by the female students do not completely dissipate, rather, over time, the students learn to identify adaptive ways to be successful as they make use of available support and guidance.

Disciplines
Disability and Equity in Education | Higher Education | Science and Mathematics Education

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Introduction and Purpose of Study

The STEM[1] pipeline is viewed as a universal metaphor representing the *"*path from elementary school to a STEM career" (Hill, Corbett, & Rose, 2010, p. 17). In the last few years, initiatives focused on strengthening the STEM pipeline have expanded in scale and emphases; from broadening the STEM pipeline to diversifying. In spite of multi-pronged efforts on the behalf of various entities, lower rates of participation in the STEM pipeline continue to prevail among individuals from ethnic, racial, and socio-economic groups; especially in physical sciences and engineering (Jacobs & Simpkins, 2005; Kahle, 2004; National Science Foundation, 2013; President's Council of Advisors on Science and Technology, 2010, 2012; Rothwell, 2014).

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Theoretical Framework

The Representation Index (RI) is defined as a "group's percent of representation in a category divided by the percent of representation of that group in the US population" (Rankins, Rankins & Inniss, 2014, p. 7). An RI of 1 indicates equal representation of a specific group within the larger population. The RI of women of color (excluding Asian/Pacific Islanders) in physical sciences and mathematics degrees is approximately measured at 0.40 (Hill, Corbett, & Rose, 2010; Rankins, Rankins & Inniss, 2014).

The underrepresentation of women of color in STEM degrees and careers "raises concerns of equity in the US educational and employment systems" (Ong et al., 2011, p. 172). It is an issue

[1] STEM; science, technology, engineering and mathematics

of social justice, parity, and possibility. It forms the roots of inequality, exclusion, and marginalization (Hill, Corbett, & Rose, 2010; McDermot & Mack, 2014; Ong et al., 2011).

Racial and ethnic diversification of the STEM pipeline in the US is significant, and also essential for many social and economic reasons. These include: reaping benefits from embracing the unique perspectives, talents, and experiences of a broader segment of the population; improving the quality of life for all Americans; providing educational opportunities to marginalized groups in the US; and realizing economic/social equity and upward mobility (Hill, Corbett, & Rose, 2010; Ong et al., 2011; President's Council of Advisors on Science and Technology, 2010, 2012).

Literature reviews by Brotman & Moore (2007) and Scantlebury & Baker (2007), reveal several themes regarding underrepresentation of minority female students in the fields of physical sciences, engineering, and mathematics. It is understood that achievement in STEM fields is not just a manifestation of individual variables; rather a cumulative expression of sociocultural, familial, and emotional factors experienced by minority women (Brotman & Moore, 2007; Scantlebury & Baker, 2007).

Within attempts to understand the issues and factors that can potentially reduce the levels of attrition of minority women from STEM fields, scholars recommend two groups of transformation (e.g., Aschbacker et al., 2010; Brotman & Moore, 2007). First is the perspective that change needs to happen within curricular and instructional structures rather than an adjustment in the attitudes of girls towards science and mathematics. Second is the integration of critical and feminist theoretical frameworks within education systems, in contrast to general and collective curricula that have become prevalent 'in order to provide boys and girls with similar learning opportunities' (Aschbacker et al., 2010; Brotman & Moore, 2007).

Research Method

Research for this paper was conducted as a sub-study of a larger investigation focused on understanding the impact of support resources by high school juniors and seniors who are interested in pursuing post-secondary STEM majors/degrees (n=32). This paper highlights from consecutive years of research and data analysis. From Years 1 & 2, the paper highlights, the predicaments and resolutions of female students from underrepresented minority groups who matriculated into physical sciences and engineering. Close to half of the female student participants in this study made advancement into post-secondary STEM studies. Their advancement was measured against the statistical odds which are frequently projected for students from comparable backgrounds (Brotman & Moore, 2007; Hill, Corbett, & Rose, 2010; NSF, 2013; Reyes, 2011). From Year 3, the study plans to share a compilation of resources, support networks, and curricular models that the students find crucial in sustaining their journeys from high school into first year of post-secondary STEM degrees.

Data Collection and Data Analysis

Using a case study analysis combined with grounded theory, the initial phase of this specific study began with female students in grades eleven and twelve (n=11). At the time of data collection, the students were enrolled in two public schools in an inner city area in the north

eastern corridor of United States. Several of the students live in subsidized housing. Regional newspapers report frequent instances of crime, poverty and neglect in the city. Homicide and heavy crime rates have been at par with the top 20 large metropolitan areas in the US.

Three instruments were exercised sequentially among the study participants over the initial two years of study. The first instrument was a survey in which participants answered a variety of questions including post-secondary aspirations and concerns/reservations about post-secondary achievement in STEM fields. All but one student participated in the first round of interviews which sought perspectives on indicators of success and achievement; sources of conflicts and concerns; social, emotional and familial factors influencing academic decisions; and impact of peer support in terms of decision making (See Table 1a).

Table 1a: Select Characteristics of Study Participants[2]

Participant*	**Racial/Ethnic Identities**	**Parent(s)' Highest Educational Background**	**Participants' Post-Secondary Aspirations in Year 1**	**Participants' Primary Concerns regarding PS STEM**
Maxine	Asian	Graduate	Health Sciences	Financing Tuition Costs
Katy	Latina	GED	Nursing	No response
Mandy	Hispanic	Incomplete HS	Computer Technology	Not fitting in at College
Daria	Black	GED	Engineering	Family Approval
Tumpa	White	Bachelors	Cosmetology	Cool Factor
Sasha	Black	Bachelors	Unsure	Several; Unsure
Bethy	White	High School	Unsure	Unsure
Zoei	White	Associate	Secondary Teacher	Finding Job
Ferrine	Caucasian	Incomplete HS	Computer Science	Family Expectations
Amy	Latina	Unknown	Nursing	Financing
Lei	Est Asian	Unknown	Pre-School Teacher	Family Approval

Finally, using a set of multiple criteria (e.g., conflicts, concerns, perceptions of familial and peer support, family SES), the study further selected students who demonstrated vulnerability in withdrawing from pursuit of post-secondary STEM majors (n=6) (See Table 1b). All the students who were selected for final rounds of interviews and extended focus groups

[2] Participants self-selected their pseudonyms as well as nomenclature of racial/ethnic identities.

demonstrated characteristics belonging to two or more categories of underrepresentation in STEM. Additionally, all six had been accepted into STEM degrees at 2 or 4 year institutions. At the end of Year 2, five matriculated into STEM degrees at 2 or 4 year institutions.

Table 1b: Sequence and extent of Participation in Research instruments

Participant	Survey	Interview #1	Interview #2
Maxine	X	X	
Katy	X	X	
Mandy	X	X	X
Daria	X	X	X
Tumpa	X		
Sasha	X	X	X
Bethy	X	X	
Zoei	X	X	
Ferrine	X	X	X
Amy	X	X	X
Lei	X	X	X

Focus groups were used to collect the six students' responses to open-ended prompts. For example, one particular focus group, attended by all students, and also identified as 'most meaningful' on participant-check surveys was titled: **What I Heard; How I Felt; What I Did.** In the next focus group discussion, transcripts from the initial focus group were shared with the students where they had a relaxed opportunity to categorize concerns and highlight a phrase that indicated their most pressing concerns (see Table 2)

Table 2: Concerns Expressed by Female minority Students regarding STEM Aspirations

Key Sources of Hesitation	**Concerns about contributing to family well-being**	**Concerns about getting alienated from friends**	**Concerns about getting alienated from family**
Instances	N=4	N=3	N=8
Examples	*I was told that I should be supporting my family and (younger brothers)* instead of asking my parents to send me to college. The counselors told me	My friends said that they were afraid that once *I went to engineering college, I was not going to hang out with them no more*. These are people with whom I grew up and practiced for Math SATs.	At Sunday dinner after church, I told my cousins…one sniggered …Eww, are you going to wear a suit and carry a black bag when you go to work? She said ewww!

	that with my good grades, I would definitely get financial aid.		And then everyone laughed again. *I didn't think it was going be that icky.*

All five students have successfully finished first year of a STEM degree and have also registered for the following year's course load leading to STEM degrees/majors.[3]

Data analysis started in February 2013 and is still evolving. All emerging findings (as of summer 2015) were categorized and negotiated between the researcher and a professional colleague. Additionally, inter-rater reliability of 80-86% was obtained from two additional colleagues with 1) knowledge of success factors in STEM and 2) principal reasons behind female students' attrition from STEM fields.

Results

This multi-year study reveals three primary sources of internal conflicts and negotiations experienced by students that are noteworthy and may help unravel the nuances of how young women of minority backgrounds perceive the intertwined and complex dynamics of participating in STEM fields/education. These emergent findings compel us to reconsider how students look at past experiences of family members and female friends in juxtaposition to personal aspirations and decisions.

In spite of the small sample size of this study, the tentative and emerging findings from this study provide insight into the nuances of socio-cultural variables in juxtaposition with how women from underrepresented groups construct notions of their advancement within STEM. The nascent results also compel us to dwell on the conflicting perceptions and assumptions that hold sway over the minds of young females from underrepresented groups in making vital decisions that might have long term impact in their personal educational/economic prospects.

For instance, the following pieces of data are vital and insightful:

- All six students indicated that they held the ability to succeed in STEM.
- Three were doubtful that pursuing STEM was going to allow them to carve a 'comfortable space' in familial and peer groups.
- In year 1, four students indicated that postponing pursuit of post-secondary STEM "for now at least" was the best option for them.
- In year 2, one student indicated that postponing pursuit of post-secondary STEM "for now at least" was still the best option.
- Only two out of six students discussed their pursuit of STEM as an aspect of opportunity or access.
- Two students indicated that in spite of hardships, the transition from high school to college was a "make or break opportunity."

Plans for Year 3

Next steps for research are in firm mode of planning and implementation. Finally, to understand

[3] At the time of proposal submission in June 2015

the factors that enabled the students to 'stay' in STEM, this year (Year 3; 2015), focus groups will be held for students to identify significant **resources, family negotiations, support networks, and academic advice/guidance**. The presenter should be able to shed light on the top 2-4 items identified by students within each of the above categories.

References

Aschbacker, P. R., Li, E., & Roth, E. J. (2010). Is science me? High school students' identities, participation and aspirations in science, engineering, and medicine. *Journal of Research in Science Teaching, 47*(5), 564-582.

Brotman, J. S., & Moore, F. (2008). Girls and science: A review of themes in the science education literature. *Journal of Research in Science Teaching, 45*(9), 971-1002.

Harris-Perry, M. (2013). Sister Citizen: Shame, stereotypes and black women in America. Yale, CT: Yale University Press.

Hill, C., Corbett, C., & Rose, A. S. (2010). *Why so few? Women in science, technology, engineering, and mathematics*. Washington D.C: American Association of University Women.

Jacobs, J. E., & Simpkins, S. D. (2005). *Leaks in the pipeline to math, science, and technology careers*. San Francisco: Jossey-Bass.

Kahle, J. B. (2004). Will girls be left behind? Gender differences and accountability. *Journal of Research in Science Teaching. 41*(10), 961–969.

Kumar, R. (2011). Using visual arts as a proxy for language: Addressing the marginalization of linguistic minority parents (Lead article in Issue). *Equity and Excellence in Education, 44*(4), 453-467.

Kumar, R. (2014). Cultivating GRIT for STEM: Contrarian perspectives of parents on failure and gendered norms. Paper presented at the Annual Meeting of the American Education Research Association (AERA), Philadelphia, PA.

Maxwell, J. (2005). (2nd Ed.). Qualitative research design: An interactive approach. Thousand Oaks, CA: Sage.

McDermott, P., & Mack, K. M. (2014). The Twenty First Century case for inclusive excellence in STEM. *Peer Review* (AACU), *16*(2), 4-6.

National Center for Education Statistics (2009). Students who study science, technology, engineering, and mathematics (STEM) in postsecondary education. U. S. Department of Education, Washington, D.C. Retrieved from, http://nces.ed.gov/pubs2009/2009161

National Science Foundation, Division of Science Resources Statistics (2013). Women, minorities and persons with disabilities in science and engineering, NSF Report 13-304, Arlington, VA: Author.

Ong, M., Wright, C., Espinosa, L. L., & Orfield, G. (2011). Inside the double bind: A synthesis of empirical research on undergraduate and graduate women of color in science, technology, engineering and mathematics. Harvard Educational Review, 81, 172-208.

President's Council of Advisors on Science and Technology (2010). Report to the President: Prepare and inspire: K-12 education in science, technology, engineering, and math (STEM) for America's future. Washington, D.C.: Author

President's Council of Advisors on Science and Technology (2012). Report to the President: Prepare and inspire: K-12 education in science, technology, engineering, and math (STEM) for America's future. Washington, D.C.: Author

Rankins, C., Rankins, F., & Inniss, T. (2014). Who is minding the gap? Gender Equity in STEM. *Peer Review* (AACU), *16*(2), 7-9.

Reyes, M. (2011). Unique challenges for women of color in STEM transferring from community colleges to universities. *Harvard Educational Review, 81*(2), 241-262.

Rothwell, J. (2014). *The hidden STEM economy*. Accessed September June 15 2015. http://www.brookings.edu/research/reports/2013/06/10-stem-economy-rothwell

Sadler, P. M., Sonnert, G., Hazari, Z., Tai, R. (2012). Stability and volatility of STEM career interest in high school: A gender study. *Science Education*, *96*(3), 411-427.

Scantlebury, K., & Baker, D. (2007). Gender issues in science education research: Remembering where the difference lies. In S. Abell & N. Lederman (Eds.), Handbook of research on science education (pp. 257-286). Mahwah, NJ: Lawrence, Erlbaum.

Stake, R. (2003). Case studies. In N. K. Denzin, & Y. S. Lincoln (Eds.), *Strategies of qualitative inquiry*. Thousand Oaks, CA: Sage.