

Reframing Science Retention and Achievement: Using an Asset-Based Approach to Examine Why Students Succeed in Science?

It is no secret that Science, Technology, Engineering, and Math (STEM) disciplines continue to struggle to retain students in their disciplines, particularly underrepresented minority (URM) students. Researchers and science-related organizations have conducted numerous inquiries into the various reasons students stay or leave their intended majors (AIR, 2013; National Academy of Sciences et al., 2011). The large majority of these investigations have focused on the factors that contribute to students' decisions to leave. These studies have provided a wealth of useful information from which to improve our undergraduate science programs. However, conclusions drawn from such studies have also focused on what students' lack (e.g. access to quality science instruction). In comparison, we know very little about why students remain in undergraduate STEM programs. I argue that it is crucial to balance our understanding of factors that contribute to student attrition with factors that contribute to student retention, especially among URM students who are constantly positioned in deficit views. In other words, it is important to investigate the various factors that contribute to students' decisions to remain in their intended STEM majors and contribute to their academic achievement. **The central aim of my current proposal is to develop a novel asset-based assessment instrument to explore undergraduate STEM retention and achievement.**

Background Literature

Various metrics have been used to define undergraduate retention efforts across institutions of higher education. The most common metric associated with retention is degree completion rates. Moreover, completion rates are commonly used to evaluate retention efforts on college campuses. According to the National Science Foundation's Science and Engineering Indicators (NSF, 2013), students earning bachelor's degrees in all science and engineering (S&E) disciplines has continually risen since 1960 reaching approximately 1.6 million in 2010 (most recent data). However, the proportion of bachelor's degrees in all S&E disciplines has remained steady over the past two decades at approximately 32%. A similar trend is observed when focusing in on URM students in S&E disciplines. For example, the percentage of Latina/o S&E bachelor's degrees increased from 7.5 to 10.1 percent between 2001 and 2012 (NCES, 2014). Although these percentages provide cautious hope, there still exist serious disparities with regard to retention across racial and ethnic lines (ibid.). The Planning, Budget, and Analysis department at CU-Boulder estimates that approximately 42% of African American and 48% of Latino students who declared a STEM major graduated in 6 years, compared to 61% for White and 66% for international students (Office of Planning, Budget, & Analysis, 2014).

Reinforcing Deficit Perspectives on Student Retention

Disparities in retention trends across ethnic and racial lines have naturally led scholars to ask question about the academic experiences of students in general and URM in particular, such as: why do so few students pursue STEM degrees? What are the common barriers URM students must traverse to graduate? Why are URM students underprepared compared to their more affluent White and Asian peers? Why do URM students leave STEM disciplines at higher rates?

In 2013, the NY Times published an article titled, “Missing from Science Class.” The article explored reasons why so few lower-income Black and Latina/o students remain in science. In the section titled, “What’s Holding Them Back” the authors cite a lack of a quality science instruction in k-12 and unqualified science teachers. Others factors such as lower expectations among URM students, lack of role models, and insufficient financial resources are also discussed. Although this news article focused on k-12 settings, similar findings have been continually reported in undergraduate STEM education (Seymour et al., 1997; National Academy of Sciences et al., 2011). Expanding Underrepresented Minority Participation, a National Academies of Sciences publication, reinforces the NY Times article by adding barriers such as preparation, access and motivation, affordability, and academic and social support as prime reasons for the lack of URM students completing science and engineering degrees (ibid.).

Reframing Retention to Focus on Assets

The evidence produced from these and other studies of retention among URM students has undoubtedly contributed significantly to our understanding of the various struggles students encounter when majoring in STEM disciplines. However, the one-sided focus on URM student disparities amplify failures and promote deficit perspectives of URM student achievement in undergraduate science. As such, **we know very little about what (and how) factors and academic experiences contribute to students’ academic success and retention** in undergraduate STEM programs, particularly among URM students.

This proposal seeks to reframe retention by exploring asset-based approach to academic success and retention. For example, rather than exploring the question “What academic experiences cause students to leave STEM fields?” I seek to explore the question, “What academic experiences are associated with students’ decisions to remain in STEM fields?” Scholars have examined influences on students’ decisions to remain in science, some of which include social factors (Harper, 2010), pre-college factors (Chang, Sharkness, Newman & Hurtado, 2010), college-related experiences such as participating in undergraduate research (Jones, Barlow & Villarejo, 2010), and institutional factors (Griffith, 2010). Although there exist a few studies exploring these facets, more work needs to be done. Few studies have collected rich qualitative data to support their findings. Even fewer studies have used qualitative data to develop a large-scale assessment that can be used to examine various factors on a broader scale. My proposal seeks to fill this gap by investigating the following research questions:

1. What pre-college socialization and preparation factors stimulate and sustain students' interest in attaining degrees in STEM fields (e.g. family, k-12 school forces, and out-of-school college prep experiences)? How?
2. What college socialization and preparation factors compel students to persist in STEM fields (e.g. classroom interactions, innovative pedagogies, research experiences)? How?

Study Design and Methods

In order to explore these questions my study will span three phases over the course of one academic year among students enrolled in undergraduate science programs at CU-Boulder. An exploratory sequential design will be used (Creswell, 2013). The first phase in this design prioritizes qualitative data collection (e.g. interviews) and analysis. Findings from phase 1 will be used to inform phase 2, which is the design of a quantitative survey instrument. More detailed information is provided below regarding forms of data and collection.

Phase 1: Material Preparation and IRB Approval (Summer 2015)

I will prepare all project materials and obtain IRB approval during summer 2015. This will include developing a semi-structured focus group interview protocol that emphasizes pre-college and college socialization and preparation factors, as well as probing questions related to potential future trajectories related to science. I will adapt the Black Male Achievement Study framework as part of the protocol (Harper, 2010). This framework was selected because its ability to elicit factors and experiences that positively influences students' decisions to remain in STEM disciplines. Although the protocol focuses on Black students, I will adapt the protocol for students from various ethnic and racial backgrounds and science majors.

Phase 2: Data Collection Using Semi-Structured Focus Group Interviews (Fall 2015)

Phase 2 will emphasize collecting qualitative interview data that will be used to inform the development of a quantitative survey instrument. The purpose of focus group interviews will be to inquire *what* specific pre-college and college socialization and preparation factors most contribute to students' academic achievement and retention in undergraduate science programs and how. In total, 10 focus group interviews containing 3 students each, organized by disciplinary major, will be conducted (30 interviews total) during the fall 2015 semester. I anticipate interviews will last approximately 2 hours per interview.

Students will be recruited from numerous science disciplines (e.g. Physics, Chemistry, MCDB, I-Phy). I will utilize assistance from the Center for STEM Learning and the DBER community to identify potential faculty teaching within these departments and courses. I will also focus on upper-division students as these students have completed lower-division courses and are more likely to remain in

science disciplines. I will then solicit students’ participation during their course lectures.

Phase 3: Qualitative Data Analysis & Survey Development

Although preliminary data analysis will be completed as data is collected to identify initial themes/patterns, the main portion of qualitative data analyses will take place during spring 2016 (phase 3). Harper’s (2010) asset-based framework will be used as an analytic tool to deductively code interview data. Separately, this study will use an inductive approach to develop themes related to both research questions. This is an iterative approach that starts with preliminary codes and moves towards building more inclusive themes. Deductive and Inductive codes will be cross-tabulated and compared to identify more thoroughly potential trends. In addition to qualitative data, descriptive student information will also be collected (e.g. science major, gender, ethnicity/race, GPA, course transcripts).

Interview findings will be used to generate a survey instrument that will investigate qualitative findings on a broader scale. The survey instrument will build directly from interviews to solicit information about students’ pre-college and college socialization and preparation associated with students’ decisions to remain in science disciplines. Although not part of this proposal, additional funds will be sought in the future to examine the technical aspects of the survey instrument (reliability and validity) before large-scale implementation.

Write Up and Dissemination (Summer 2016)

Writing qualitative findings will take place throughout the entire project as a way to reflect and organize thoughts. However, summer 2016 will focus on disseminating research results to larger audiences through conference proposals and a peer-reviewed publication.

Timeline & Budget

Table 1 shows a proposed timeline for the implementation of this study. I will develop and refine my project materials, as well as obtain IRB approval during the summer 2015. The fall 2015 semester will be used to conduct focus group interviews and begin preliminary analyses (phase 2). The main portion of qualitative data analyses will take place during spring 2016 and generate a survey instrument that will investigate qualitative findings on a broader scale (phase 3). Finally, write-up and dissemination of research results will occur during summer 2016.

Table 1: Project Timeline by Phase

	2015		2016	
	Summer	Fall	Spring	Summer
Phase 1: Prepare Materials & Obtain IRB Approval				

Phase 2: Qualitative Data Collection				
Phase 3: Qualitative Data Analysis & Survey Development				
Write up and Dissemination				

Table 2 provides a list of the resources along with approximate costs I am requesting in order to complete the study. The resources include tools to collect data (e.g. audio recorders), compensation for participants, qualitative data analysis software, and funding to hire an undergraduate Learning Assistant to serve as a research assistant for an academic year.

Table 2. Line Item Budget

Description	Cost
Audio recorders (x2)	\$150
Faculty summer salary (1 summer month)	\$5,250
Participant Pay (2 hour interview x 30 participants x \$10 per hour)	\$600
Undergraduate Learning Assistant (LA) Research Assistant (\$10/hr x 10 hrs/week x 15 weeks x 2 semesters – Fall 2014 and Spring 2015)	\$3,000
Qualitative coding software	\$550
Total	\$9,550

Outcomes/Impacts

The current study is expected to offer several important contributions to the STEM educators, researchers, and policy makers. First, this study attempts to reframe the way educators, researchers, and policy makers think about retention efforts. The published literature contains numerous studies that document various barriers that contribute to students’ decisions to leave the sciences. However, little is known about factors that contribute to decisions to stay. My study will focus on pre-college and college factors and experiences that contribute to students’ decisions to remain in science disciplines. Second, CU-Boulder administrators and faculty in science departments will benefit by gaining knowledge of “what works” to keep students in science programs. Finally, research findings will be used as a springboard for an NSF grant proposal or NSF Early Career Award (CAREER) in 2017.

CU-Boulder is a national leader in STEM education. As such, we have a commitment to all students to continually improve our science education program for the next generation of scientist and scientifically literate citizens. Funding this

proposal will be another step in that direction. The Chancellor's Fellowship will go a long way to reframing our understanding of retention efforts from deficit views to asset-based perspectives. Thank you for the opportunity to apply to the Chancellor's Fellowship Award.

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