Underrepresented Minority STEM Persistence in College: A Narrative Identity Approach

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Abstract

Female students and those from Latino(a), African American, and Native American background are underrepresented in STEM (science, technology, engineering, and mathematics) classes in college, teaching positions, and careers. This study focused on sense of belonging, academic self-efficacy, motivations to pursue STEM, and gender and racial identity intersectionality with STEM. This study uses a longitudinal, narrative approach: college students who expressed interest in majoring in STEM when entering college wrote narratives based on narrative identity prompts at three time points up until they declared their major, two years into their college careers. We found that underrepresented ethnic minority students were less likely to persist in STEM than their white and Asian peers, but that women were just as likely as men to persist in STEM. Underrepresented students rated themselves lower in perceived competence and self-efficacy. Future studies coud look into how multiple STEM-minority identities affect STEM persistence.

In the United States, women and some ethnic minorities (i.e. non-whites and non-Asians) are underrepresented in science, technology, engineering, and math (STEM) fields, from majoring in a STEM subject in college to actually pursuing a STEM career (Hill, Corbett, & Rose, 2010). This issue exists separately for women and underrepresented minorities, but is heightened for women of color who earn fewer Bachelor's degrees and doctoral degrees in STEM than white women and men of color, despite showing a similar level of interest in the STEM fields (Ong, Wright, Espinosa, & Orfield, 2011). In addition to the social inequity of this phenomenon, Ong and colleagues (2011) highlight the loss of human capital and societal consequences this disparity causes. It is possible that women of color who are interested in science have been turned away from pursuing a career in STEM due to systemic barriers.

The STEM achievement gap is a problem for both women and people of color and there is extensive literature that looks at the problems facing these groups separately. Often literature will report findings that either focus on people of color of all genders, women of all ethnicities, or women of color. It is also important to note that ethnic minority women are less represented in STEM than ethnic minority men (Mullen & Baker, 2008). The additional struggles of women of color are often not considered in minority-STEM literature, but minority women do face even more barriers than a single-minority group as they have double-minority status in terms of STEM participation (Ong, Wright, Espinoza, & Orfield, 2011; Macphee, Farro, & Canetto, 2013). This study aims to examine all of these groups simultaneously, and consideration of this "double bind" will be taken into account. Ong and colleagues (2011) posit that interventions focusing on just one minority status may not be sufficient to help women of color. While the reasons and nuances differ between women and ethnic minorities, the themes of stereotyping, discrimination, and stigma are central to the struggles women and underrepresented minorities face when pursuing STEM.

While there are differences in college experiences between majority and underrepresented students, there are also aspects of college life that help improve the wellbeing and efficacy of any student, regardless of ethnicity or gender. Seymour and Hewitt (1997) studied both minority and majority students and found that overall the biggest problems reported by those who switched out of STEM were loss of interest in the subject, gaining interest in a non-STEM subject, difficulties with STEM faculty, and being overwhelmed by the workload. These reasons certainly may affect all students, but underrepresented minorities are especially at risk for being negatively affected by these factors because of the additional difficulties faced by these students due to systemic biases favoring majority students (MacPhee et al., 2013; Crocker, Major, & Steele, 1998).

The process of developing interests that inform college major is larger than the single decision to major in STEM. The process leading up to a STEM major has often been described as a “pipeline” that includes both precollege experiences, like high school, and can be thought of to even include postcollege experiences, like actually working in a STEM profession. STEM fields are associated with high status and power, and these are aspects of society American culture that traditionally been kept away from women and underrepresented minorities (Fox, 1999). Because of this, the problems of racism and sexism at both the institutional and individual level are at work and intertwined with the solutions of how to improve the disparity in STEM.

Jones (2000) provides a framework that splits racism into three levels: institutionalized, personally mediated (discrimination), and internalized. All of these levels are present when considering the STEM pipeline issue. Institutionalized racism is present in keeping ethnic minorities in lower socioeconomic statuses (Jones 2000), which includes being less financially secure, but also having limited access to education or opportunities to increase one's social status. Personally mediated racism includes prejudice, or how others prejudge one's abilities, and discrimination, or being treated differently because of race. In a society that is it at least somewhat conscious of race and avoiding racism, unconscious racist acts still come through. These are known as microaggressions (Nadal, 2011) and may occur in a STEM class when a majority student expresses surprise at the success of an underrepresented minority student. Internalized racism is when these negative stereotypes are internalized, and in STEM this might look like someone who does not believe they have the ability to succeed because of the stereotypes about their race that they have internalized.

As with racism, gender-STEM stereotypes negatively affect an individual's psychology but also affect how women are treated in STEM. Work done by women in professional and academic contexts is often undervalued, while work done by men is overvalued (Valian, 1999). This applies to STEM fields in college, and this implicit bias creates a culture that favors men. This effect can subvert women's interest in STEM and lead them to become interested in other career paths (Cheryan et al., 2009).

Ong and colleagues (2011) bring up the myth that underrepresented students, and especially women, simply have less interest in pursuing STEM, and this is the reason there are fewer minority women in science. Underrepresented minority women are just as interested in STEM as white men (Bonous-Hammarth, 2000; Chipman & Thomas, 1987), but factors including institutional failures to include women and nurture their scienctific skills (Carlone & Johnson, 2007) prevent them from proceeding to success (Ong et al., 2011). This assumption has sexist undertones, as it presumes women want to follow “traditional” gender roles, and it can also inform the way women are treated in STEM fields.

There are also implicit stereotypes that boys are naturally better at STEM classes and that men are more interested in science (Nosek et al., 2009). Having internalized beliefs of inferiority, or having anxiety about confirming these beliefs, is known as stereotype threat (Spencer, Steele, & Quinn, 1999). It is important to note that stereotype threat is a problem that can occur not only through internalized racism or sexism, but also even without internalized stereotypes in an environment where one is afraid of being judged according to negative stereotypes (Shapiro, 2011). Stereotype threat can cause underrepresented ethnic minorities to underperform in STEM and the same effects have been found for women (Schmader, Johns, & Barquissau, 2004**).**

The goal of this study is to examine the factors that have been shown to predict STEM persistence through a narrative identity approach. Four categories we plan to study that we think are particularly important for underrepresented students in STEM are belongingness and support, self-efficacy and academic self-concept, motivations for pursuing STEM, and identity intersectionality. The reasons found by Seymour and Hewitt (1997) map onto our current theoretical framework. A low sense of belonging could lessen interest in a subject and cause a disconnect with faculty. Having low self-efficacy could lead to being overwhelmed by the workload. High extrinsic motivation or low intrinsic motivation could lead to a loss of interest or gaining interest in a different field. Conflict between identities leads to gaining interest in a non-STEM subject (Syed, 2010). As will be investigated, these conflicts of identity, sense of belonging, and self-efficacy may play an even larger role for underrepresented minority students.

Belonging, Role Models, and Social Context

Belonging in this study is meant to encompass both belonging within one's institution and a sense of belonging within one's chosen major. Wanting to belong is fundamentally human (Baumeister & Leary, 1995). A healthy sense of belonging generally promotes emotional well-being and cognition while a lack of belonging can be harmful to an individual's mental health. In school, a sense of belonging aids in social connectedness, protecting people from becoming too discouraged by academic setbacks, and a greater connection with a teacher or mentor leads to a better learning environment (Mahoney & Cairns, 1997; Furrer & Skinner, 2003). Students of color are at risk for having belonging uncertainty in college because they are underrepresented in higher education, but also because of stigma they may face (Walton & Cohen, 2007).

Women are not minorities on college campuses, but they are likely to be minorities in their STEM classes (Hill et al., 2010). Because of the simple fact that they are minorities in these classes, they may feel a lower sense of belonging (Dasgupta, 2011). This is significant because women scoring higher on belonging showed greater intent to pursue math later on (Good, Rattan, & Dweck, 2011), meaning lower scores on belonging could lead to a lower persistence rate. Several belonging factors that were found to predict persistence for women of color were discussing course content with peers, joining STEM-related organizations, participating in undergraduate research, and attending a college with a strong STEM community (Espinosa, 2011).

Having representative role models can increase belonging. Out of the other factors that affect belonging, role models may be one of the easier interventions for institutions to implement because they have the power to hire science professors who are women or people of color. Mentorship programs have shown that having more representative mentors is a possible answer to decreasing the STEM gap (Toven-Lindsey, Levis-Fitzgerald, Barber, & Hasson, 2015; MacPhee, Farro, & Canetto, 2013).

Underrepresented ethnic minorities are minorities in the general population, and also in STEM classes. In 2010, underrepresented minorities made up 29% of the U.S. population, yet accounted for only 15% of STEM Bachelor degree recipients (Estrada, 2016). The presence of a black STEM professor increases black students' persistence and interest in STEM (Gasman & Nguyen, 2016). This echoes research by Dasgupta (2011) showing the presence of ingroup peers and experts in a field can help protect against negative stereotypes. This may help explain why Historically Black Colleges and Universities produce a higher proportion of African American students who pursue STEM graduate degrees (Gasman & Nguyen, 2014).

A similar effect has been found for women. Women professors and experts improved women's self-efficacy, science identity, and commitment to the field (Stout, Dasgupta, Hunsinger, & McManus, 2011). This finding shows that increased belonging, by having more female experts, positively affects other facets of a students' success. A higher percentage of women professors in STEM has also predicted greater number of women students persisting (Sonnert, Fox, & Adkins, 2007). This issue expands beyond simple representation. The job of a role model is not simply to represent a successful person in a field, but to help mentees with their personal struggles, and a woman or person of color may be in a better place to understand and empathize with their students who may be facing stigma because of their identity.

Facing stigmas and stereotypes can lead to a lower sense of belonging. Stigma itself is characterized as when someone has, or believes they have, attributes that are less valued in certain contexts (Crocker et al., 1998). Being stigmatized has many harmful effects including facing increased discrimination, having stereotypes automatically activated, and having one's stigmatized identity threatened (Major & O'Brien, 2005). Automatic activation of stereotypes is one of the mechanisms that enables stereotype threat, so stigma is directly related to an increased likelihood of stereotype threat. Social belonging is also different for black and white students. When belonging was experimentally manipulated, black students responded more negatively than white students to the idea of having fewer friends in an intellectual setting (Walton & Cohen, 2007). Because ethnic minorities are more likely to be stigmatized on college campuses in general, they are less likely to develop a secure sense of belonging, which in turn is likely to undermine their academic performance and motivations. As Walton and Cohen (2007) showed, this is a challenge not faced by white students because they are not stigmatized academically, so they have an assumed sense of belonging. The problem is complicated by the fact that stronger ethnic identification predicts greater discrimination from white students (Kaiser & Pratt-Hyatt, 2009), showing that minority students are being tacitly encouraged to assimilate.

Assimilation, accomodation, and resistance have been outlined as three distinct approaches Latino college students are faced with to reconcile their minority identities with majority culture at college (Rivas-Drake & Mooney, 2009). Assimilators feel the least ethnically different from whites, while accomodators feel ethnically distinct from whites but believe that minority students have equal opportunities to whites. Resistors feel ethnically distinct and also that opportunities for minority students are unequal.

Latino students, both men and women, who identified more strongly with "system-justifying ideologies" were found to have a higher score in belonging but also lower grades (O'Brien, Mars, & Eccleston, 2011). Some of these system-justifying ideologies overlap with American cultural norms, such as the importance of independence and self-reliance, and the tendency to make internal attributions for failure instead of blaming societal problems. This measure is comparable to whether someone is an accomodator or resistor (Rivas-Drake & Mooney, 2009) as it measures beliefs about fairness in society. This finding highlights the problem faced by underrepresented ethnic minority students of incorporating majority values for the sake of belonging. Although in this case belongingness was associated with lower grades, this finding is not contrary to literature showing the benefits of belonging, but rather shows the nuanced way in which belonging can help ethnic minorities. This may suggest that belonging can help, but it should be done with care to promote ethnic identity rather than diminish it. At the same time, this may increase prejudice from majority students (Kaiser & Pratt-Hyatt, 2009). Perhaps interventions for increasing ethnic minority belongingness could focus on both majority and minority students, as the majority students' attitudes and beliefs clearly play a role in determining minority students' belongingness.

Tinto (1993) suggests that ethnic minority students must assimilate, or break away from their traditions, to succeed in predominantly white American colleges. However, assimilation, as could be expected, has some negative consequences. Breaking away from past cultural traditions and supportive relations rooted in one's culture can be harmful to minority students (Tierney, 1992). Ethnic minority members who endorse assimilation over multiculturalism (a similar measure to accomodation) identify less strongly with their ethnic in-group and also evaluate their in-group lower (Verkuyten, 2005). Lower in-group evaluations due to assimilation may be associated with lower self-efficacy and has the potential to increase the negative effects of stereotype threat. Furthermore, when multiculturalism was embraced, majority group members evaluations of minority groups were higher (Verkuyten, 2005), showing that multiculturism over assimilation can help reduce prejudice towards minority students. Another benefit of culture integration is that it increases well-being in the workplace, while marginalization negatively impacts well-being (Peeters & Oerlemans, 2009).

Some more subtle factors in the area of belongingness relate to the differences in individualistic and collectivistic cultures. Markus and Kitayama (1991) identified the terms independent self-construal to describe more individualistic societies, like the United States, and interdependent self-construal to describe collectivistic cultures, like East Asian cultures. Within the individualistic United States, students of color are more likely to endorse collectivistic values (Guiffrida, 2006). This may mean that a sense of belonging or lack thereof is even more of an important factor for students of color than white students. Cross and Madson (1997) applied this theory to describe differences between men and women, arguing that women have a more interdependent self-construal than men.

Belongingness may affect women and men differently. Smith et al. (2012) found men reported less academic belonging than women and posited that there may be gender differences in self-reporting and need for belonging, such that women may require higher levels of subjective belonging to truly feel the benefits of belonging. Women having more interedependent self-construals might explain Smith and colleagues' (2012) findings that women may need a higher sense of belonging than men to feel that they belong. In fact, women of color who went to a college with an aleady existing close-knit STEM community tended to persist in their STEM field, highlighting the importance of a sense of belonging and community (Espinosa, 2011).

Single-sex programs have been implemented to increase women's belonging in STEM, and other factors such as social support and perceived identity compatibility with STEM have also been improved by these interventions (Rosenthal, London, Levy, & Lobel, 2011). There are mixed findings as to whether single-sex classes do increase women's performance. It may also be necessary to change the curriculum to achieve a more positive effect (Haussler & Hoffman, 2002). However, women's perceived dissimilarity to other students, professors, and others in the field was the biggest reason women had a lower interest in computer science (Cheryan & Plaut, 2010). This finding emphasizes the importance of perceived representation and belonging, and single-sex classes might ameliorate this issue and increase women's interest in STEM. Hazari and colleagues (2013) tested many factors involved in a single-sex intervention and found that the only factor that had a significant effect was discussing the underrepresentation of women in STEM. Other factors, including single-sex classes, female professors, female guest speakers, and discussing female scientists in class, did not have positive effects, suggesting that addressing the problem more directly may have the most positive effects (Hazari et al, 2013). A single-sex class may lower stereotype threat because it would decrease the number of out-group members present and therefore lower the anxiety women may have of confirming negative stereotypes in the eyes of out-group members.

There are positive impacts of belonging and negative impacts for lack of belonging. Feeling comfortable in a space lowers stigma and stereotype threat, while feeling discriminated against has the potential to create conflict between cultural identities and raise doubts that one can succeed. In this way, belonging is important not only because it makes students more comfortable, but also because it increases their sense of self-efficacy and science identity.

Self-Efficacy and Science Identity

Managing the workload is an essential part of succeeding in a STEM field (Seymour & Hewitt, 1997). We conceptualized this aspect of studying STEM as confidence in one's abilities and one's identity as a scientist. Self-efficacy describes people's beliefs in their own competence and affects the level of effort and decisions people make when faced with challenges (Bandura, 1986). Self-efficacy has been shown an important predictor for performance in science across all genders and ethnic groups (Lent, Miller, Smith, Watford, Lim, & Hui, 2016). Factors that affect self-efficacy are performance, observational learning, feedback, and emotional states including stress and anxiety (Pajares, 2005). These factors reinforce themes discussed in the belongingness, role models, and social context section. Mentors and role models, especially those who share the student’s gender and ethnic identity, can be a source of observational learning that influences a student’s sense of competence. Meanwhile, both implicit and explicit stigma negatively affects the feedback underrepresented students receive in STEM. Salience of stereotypes, a symptom of stigma, increases student’s anxiety and this in turn affects self-efficacy. Self-efficacy is also important because of its importance in developing a “science identity.”

Science identity is used here to describe how much someone sees themselves as a scientist, and was found to be an even greater predictor of STEM persistence than self-efficacy (Estrada, Woodcock, Hernandez, & Schultz, 2011). Estrada and colleagues (2011) say that this may be because science identity reflects a deeper identification and commitment to STEM than does scientific self-efficacy alone. Higher science identity has been associated with more goals focused on developing competence and fewer goals based on avoiding being seen as incompetent by others (Hernandez et al., 2013). Hernandez and colleagues (2013) found that the only goal that category that predicted STEM persistence was a lower level of the goal of avoiding looking incompetent. Avoiding doing badly is a goal that may change over time and naturally decrease as students become more engaged in STEM, as a lot of scientific research involves failing to conduct experiments or prove hypotheses. These less healthy goal mindsets may decrease as science identity increases.

Performing undergraduate research has been shown to be one of the most important actions an undergraduate student can take to develop confidence, scientific self-efficacy, science identity, and more specific scientific career goals (Estrada et al., 2011; Russell, Hancock, & McCullough, 2007). Underrepresented minority students are often less exposed to science career options than majority students, so expanding undergratuate research opportunities with a focus on recruiting underrepresented minorities may be a way to improve science identity for these groups (Russell et al., 2007). The presence of mentors and role models in undergratuate research programs may also be a reason for its positive effects on science identity and increase in belonging these opportunities bring (Russell et al., 2007).

Carol Dweck's work on fixed and growth mindsets has shown that when someone has a growth mindset towards a goal, meaning they see difficult tasks as opportunities to learn and grow, they are more likely to succeed (Dweck & Leggett, 1988). An entity, or fixed, mindset describes someone who views their ability as unchanging, and are more likely to mount a helpless response when faced with a challenge. Dweck and Leggett (1988) also observed fixed mindset children were more likely to focus on their own inadequacy and allow failures to hurt their self-esteem, while growth mindset children were able to use more effort and focused on developing strategies to improve in the future. College students are likely to believe that math skills, more than reading and writing skills, are related to innate ability, and these beliefs have been shown to negatively affect performance in math (Gunderson, Hamdan, Sorhagen, & D'Esterre, 2017). Because of this, developing a more growth-oriented mindset may be even more important for STEM students than non-STEM students. Learning that math ability could be learned rather than being an innate skill reduced the negative effects of stereotypes affecting women in math (Good, et al., 2011). Knowing that math skills can be learned rather than being innate may allow someone to feel they have more agency and increase their self-efficacy for math.

Stereotype threat against underrepresented students in STEM can also be thought of in terms of fixed and growth mindsets. The mechanism by which stereotype threat operates, i.e. when underrepresented minorities are implicitly or explicitly worried about confirming a negative stereotype, is also similar to having a fixed mindset, as a fixed view of intelligence is congruent with the negative stereotype. Growth mindset has been theorized to be an inoculation against negative motivations and outcomes (Dweck & Leggett, 1998). Adopting growth mindsets has been used as an intervention that did raise the scores of African American students more than white students by alleviating stereotype threat (Aronson, Fried, & Good, 2002).

However, a caveat to approaching stereotype threat this way is that racial/ethnicity stereotypes are less likely to be a threat to underrepresented minority students if they themselves have not internalized the stereotype (Shapiro, 2011). Teaching growth mindsets to underrepresented minority students may only be helpful to those who have internalized negative stereotypes about their group, but not be helpful to those who are worried about others' stereotypes but not their own. However, underrepresented minorities may still be susceptible to stereotype threat when performing around out-group members who they think harbor negative stereotypes. In these cases, interventions for alleviating stereotype threat should perhaps focus on fighting the stereotypes held by out-group members, in this case, the majority STEM students.

Though utilization of a growth mindset is helpful in STEM fields, the concept of using mindsets as a way to alleviate stereotype-related problems in the classroom can be problematic as it places the onus on the individual experiencing the negative stereotypes. Embracing a growth mindset and focusing on learning does require effort, and making a more ostensible effort than someone else decreases perceived self-efficacy. In male-dominated fields, female STEM graduate students saw themselves as having to expend more effort than men to succeed in their fields, and this contributed to a decrease in motivation and sense of belonging (Smith, Lewis, Hawthorne, & Hodges, 2012).

Focusing on combating the systemic problems of stigmatization and stereotyping of underrepresented students is a fairer and perhaps just as effective method of increasing self-efficacy. Group-oriented approaches that emphasize in-group success have been shown to alleviate stereotype threat and led to underrepresented students performing equally to majority groups (Shaffer, Marx, & Prislin, 2013). Furthermore, Schaffer and colleagues (2013) found that women performed better when told that women are equally represented in STEM, indicating the importance the achievement gap iteself plays in undermining self-efficacy. This is another point for how important belonging is when for women in STEM. Even small details, such as the posters on the walls of a classroom, can affect ambient belonging, and more neutral posters have been shown to help alleviate stereotype threat (Cheryan, Plaut, Davies, & Steele, 2009). Both of these examples show that increased belonging can decrease the negative effects of stereotypes and ultimately increse self-efficacy.

Women who had strong gender identification and more implicit biases against women in science were shown to perform worse in math and show less interest in math-related careers (Kiefer & Sekaquaptewa, 2007). This effect is weaker for African American women, partly because they have weaker implicit biases against women in STEM (O’Brien, Blodorn, Adams, Garcia, & Hammer, 2015). Interestingly, young African American women also express more interest in STEM than young white women (Hanson, 2004). Some cultural differences such as expectations of high self-esteem and independence for African American women, might help explain this difference (Hanson, 2004). However, as participation in STEM for African American women remains low, there are clearly some other barriers besides the issue of self-efficacy facing African American women (Hill et al., 2010).

While African American women may have some protections against negative self-efficacy in STEM, Hispanic women are especially at risk, reporting the lowest self-efficacy in science behind men and white and African American women (Hazari, Sadler, & Sonnert, 2013). Self-efficacy is centered around the self, but factors such as home environment, mentor influences, and school experiences play important roles in initiating the formation of science identity (Jackson & Suizzo, 2015). These environmental factors shows the importance belongingness plays in forming a science identity, and that belongingness and self-efficacy may be related factors that both contribute to each other and to the solidification of a science identity.

Burnout can also be a way to conceptualize changing out of STEM. Burnout is defined in three parts: inefficacy, exhaustion, and cynicism (Maslach & Jackson, 1981). Being more intrinsically motivated has been shown to buffer the personal accomplishment (inefficacy) aspect of burnout, but not exhaustion or cynicism (Rubino, Luksyte, Perry, & Volpone, 2009). Inefficacy, exhaustion, and cynicism are all aspects of college life that minorities and women may be disproportionately affected by. Underrepresented students are at a higher risk for having low self-efficacy, especially white and Latino women (Hill et al., 2010). In addition, microaggressions, such as racial jokes, against minority students lead to exhaustion for minority students, but does not affect majority students (Yosso, Smith, Ceja, Solórzano, 2009). Ethnic differences in experiences of cynicism have not been studied very much in the literature, though it would make sense that frustrations with stereotypes or microaggressions might increase cynicism. These factors and additional pressures faced by underrepresented students in STEM could lead to an increased risk for underrepresented students to experience burnout in a STEM field.

Whether caused by stereotype threat, a fixed mindset, or burnout, negative self-efficacy can make a task seem extremely difficult or impossible, and this hopelessness saps motivation to continue. Positive self-efficacy makes tasks seem possible, makes it easier to get back on track after a setback, and creates an environment that cultivates motivation to succeed.

Motivation

What motivates students to choose their majors? Self-Determination Theory emphasizes the importance of goals being self determined, and is operationalized through autonomy, competence, and relatedness (Ryan & Deci, 2000). Aspects of these themes have already been addressed in this review through the concepts of belonging and self-efficacy. Relatedness describes one’s need to belong, and competence and autonomy are directly related to self-efficacy. The additional value of Self-Determination Theory is separating goals into two distinct categories based on whether they are intrinsically motivated or extrinsically motivated (Ryan & Deci, 2000). Intrinsic motivations include the inherent emotional rewards for completing a task and whether the task is in accordance with their value system. Extrinsic motivations, on the other hand, include avoiding guilt or striving for external rewards, such as money (Sheldon & Elliot, 1999). Studies of self determination theory show that when goals are pursued because they are intrinsically valuable, the result is more positive wellbeing and higher dedication to one’s work (Ryan & Deci, 2000). Intrinsic goals and autonomy-supportive environments were shown to increase persistence in a task (Vansteenkiste et al., 2004).

Intrinsic motivation is the most studied in terms of positive academic outcomes, but examining various forms of extrinsic motivations may provide a more complicated picture. Self-Determination Theory would suggest that extrinsic motivations would lead to less dedication to goals and negatively impact persistence for STEM majors. However, there are some extrernal motivators for choosing a major, such as financial concerns and familial obligations, that are more prevalent in some cultures. Filipino and Latino young adults were found to have the strongest sense of familial obligation, but familial obligation was also associated with positive well-being (Fuligni & Pederson, 2002). Therefore, it is necessary to consider that there may be some positive external motivators, and that the congruence of external motivations with well-being should be taken into account. Because the external motivator family obligation may be highly valued by someone depending on their culture, the central focus for external motivators should not be on the fact that they are external, but on whether or not they create emotional conflict for the individual. Relating to STEM persistence, having fewer goal conflicts will probably predict STEM persistence, and having more conflicts will probably predict switching out. This might not be true, however, for those who have lots of external pressure to major in STEM while they personally do not want to pursue that major. In some cases, external pressures may outweigh internal motivations in a way that the individual is not happy with, but may end up with the end result of STEM persistence, but negative emotional well-being.

Another important external motivation for choosing a STEM major is that it will lead to a job that will allow for advancement in socioeconomic status. These may be especially important for students from a lower socioeconomic background, and they may also be an extension of their parents’ goals (Cooper, Domínguez, & Rosas, 2005). The idea of making money to support themselves or themselves and their family may be more enticing than those who already come from a higher socioeconomic status.

Women are more likely than men to choose a career based on goals geared towards helping others or a specific community (Su, Rounds, & Armstrong, 2009). Having these communal goals negatively predict STEM participation, even when controlling for self-efficacy (Diekman, Brown, Johnston, & Clark, 2010). While women are well represented in biology and chemistry, they are underrepresented in computer science, engineering, and physics (Cheryan, Ziegler, Montoya, & Jiang, 2017). This could be due to communal or helping goals that can be realized with a major in biology, such as becoming a doctor. Those types of goals are less clear in fields like physics and computer science. This effect has also been found for underrepresented ethnic minorities in STEM. Native American students who had communal goals and expressed interest in STEM fields were often disillusioned by the lack of connection between their desires to help their community and the STEM subject they were studying (Smith, Cech, Metz, Huntoon, & Moyer, 2014).

If this type of goal is central to a female or ethnic minority student's identity, it may be harder for them to reconcile their gender or ethnic identities with their science identity, and this identity conflict is further explored with the concept of identity intersectionality.

Identity Intersectionality

This study is examining the intersection of three identities: science identity, ethnic identity, and gender identity. The more central ethnic identity is, the more an ethnic minority student may be compelled to major in a field that is compatible with their identity (Syed, 2010). Subjects in the humanities or social sciences can be related more directly to ethnic identity than STEM fields, and this opportunity for ethnic identity exploration may entice non-white students to switch out of STEM fields where identity exploration is not a focus (Syed, 2010). This was also found for women scientists. When gender and science identities were perceived as incompatible, conflict was created and this can negatively affect performance in STEM (Settles, 2004). As has been mentioned, women and underrepresented minorities who are more likely to be motivated by communal goals may experience identity conflicts between their science identity and ethnic or gender identity, and this may pull them away from STEM (Su et al., 2009; Smith et al., 2014).

Working in an undergraduate lab has been shown to be a positive predictor of STEM persistence because it increases a sense of belonging and encourages a relationship with a mentor, but also because it gives underrepresented students a chance to build their science identity. As a science identity becomes more central, it protects against the negative effects of identity conflict underrepresented students may face (Settles, 2004).

Sometimes the boundaries to succeeding in STEM can be compounded by the interaction of underrepresented identities. The “double bind” of being a woman and underrepresented ethnic minority face the barriers of both racism and sexism when trying to enter a science field (Ong et al., 2011). Double-STEM minority status, was found to be worse for STEM outcomes than single-STEM minority status (MacPhee et al., 2013). MacPhee and colleagues (2013) did use low socioeconomic status as one of its underrepresented minority criterion, which the current study is not looking at in great detail, but gender was also been found to play a role in double-minority status.

Examining interactions between identities, necessitates the use of a qualitative framework that allows participants to be free to explore their intertwining identities.

Narrative Identity

College students are continuing to develop their identity past their teen years. The ages of 18-25 coincide with the developmental stage of “emerging adulthood,” that sits between adolescence and adulthood and is characterized by independent role exploration (Arnett, 2000). Narrative identity is also being developed during this time (McLean, 2008). Narrative identity involves studying how one makes connections between events and self-perceptions and the development of one’s identity and life story (Pasupathi, Mansour, & Brubaker, 2007). Children are not really capable of telling their life stories, but adolescents begin to develop the skills that let them make connections between past events and current identity and examine how the self has changed over time (McLean, 2008).

The narrative identity approach to studying personality is more often focused on general questions about identity, but it is less frequently used when looking at specific identity development, such as how underrepresented minorities experience STEM fields in college. There are a couple of advantages to using narrative identity in this context. Because narrative questions are open ended, participants can give a wide range of responses that will add a useful breadth of understanding to the STEM persistence question. Themes in the narratives will emerge organically and then we can see if they map onto our theoretical framework or not. These narratives can be coded to see if the student has had a positive or negative experience in STEM classes, with STEM professors, or at college in general. It is also important to notice how the participant interprets the event and incorporates it into their identity. For example, including more redemption sequences, where a story begins emotionally negative but ends positively, in narratives generally predicts more positive outcomes and more positive mental health (McAdams & McLean, 2013).

Narratives also give insights into how one will change over time, and this is enhanced by the current study's longitudinal design that allows us to examine how the participants' identities developed over two years. College students, and especially underrepresented minorities in STEM, have multiple identities that they are reconciling with. Perhaps what is most useful in using narrative identity to look at STEM persistence is that the narrative data could help disentangle these interweaving, yet distinct identities and reveal which are most salient and influential in each participant's decision making processes. Overall, studying underrepresented students' persistence in STEM through a narrative identity framework is a novel approach and has the potential to add valuable insights not found through other measures.

Current Study and Hypotheses

This study is using a subset of data from the Identity Pathways Project (IPP). IPP is a longitudinal study of college students, combining an array of quantitative and narrative measures to look at general questions of identity development throughout the college years. This study tracked students who noted an interest in STEM the summer before college through their first two years of college. Six waves (three per year) of data were collected, up until the participants their sophomore spring when they declared their majors. Through measurements of belongingness, self-efficacy, motivations, and identity intersectionality we hope to gain an understanding of why they persisted with STEM or switched out. Interactions of both gender and ethnic identities will also be examined to help build a clear picture of what predicts persistence.

We expect to find that women and underrepresented minorities will be less likely to declare a STEM major, as this disparity has been extensively researched and replicated (Hill et al., 2010). A greater sense of belonging (both at school and within one's major, including more role models and support within STEM fields) will predict STEM persistence for women and underrepresented minorities. This is because role models, insitutional, and social support have all been shown to be positive predictors of STEM, and microaggressions negatively impact belonging at college and within a field. We expect that scientific self-efficacy will predict higher science identity, and this will predict STEM persistence for all genders and ethnicities, which is supported by findings that science self-efficacy leads to developing a science identity which predicts STEM persistence. We also think underrepresented minorities may be at risk for having less science self-efficacy and lower science identity, which will predict declaring a non-STEM major. This may be due to things like stereotype threat and less exposure to STEM fields and opportunities.

We think that intrinsic motivation will predict STEM persistence for all genders and ethnicities, as this has been shown to be a factor for everyone regardless of majority-minority status. We also think that external motivations will be more common for underrepresented minorities, but will not predict switching out of STEM due to cultural differences in how community-focused and family-focused motivations are valued.

Acknowledging that identity exploration and intersectionality is a factor in major choice will be more common for underrepresented minorities and women because identity is more salient among these groups. Conflict between gender and ethnic identities and science identity will be negatively correlated with persistence, while integrating these identities with science identity will be positively correlated with persistence. This fits with literature showing that science identity centrality is a protector against negative self-efficacy for underrepresented minorities. However, gender and ethnic identity integration without science identity integration will be negatively correlated with STEM persistence, as this might increase the connection to a non-STEM field where ethnic or gender identity is explicitly studied.

This study takes a broad-stroke approach to studying the STEM-gap problem. While we may not be able to study each area extremely in-depth, there are a few advantages to this. We are not proposing that these factors affect persistence independently, but instead interact with each other to ultimately predict persistence. In addition, our narrative approach may be especially helpful in teasing apart which factors are interacting most strongly with which. The longitudinal design is additionally important because studying only the first year of college can yield an incomplete picture, especially for minority students (Farver, Sedlacek, & Brooks, 1975).

Method

Sample and Procedure

The data we used for this study comes from the Identity Pathways Project (IPP), a longitudinal study that involves students from Haverford College and Western Washington University. The current study used data from 6 waves of IPP, the first taking place the summer before college and then again during each subsequent winter, spring, and fall for the next two years, until spring of sophomore year (see Table 1 for depiction of when each wave occurred). At Wave 1, N = 638 participants, including both male and female participants as well as a range of ethnic backgrounds including white, Asian, Hispanic/Latino, black, and Native American. For this study, our sample was those who expressed a potential interest in STEM at Wave 1 and participate again at Wave 6, with at least two additional waves of participation in between (Wave 2, 3, 4, and 5). We defined STEM majors as biology, chemistry, math, physics, and computer science majors. All humanities and social science majors including psychology were defined as non-STEM majors. Premedical students did not count as STEM if they planned to major in a non-STEM major. Minors, even in fields that could be considered STEM, like neuroscience, did not count as STEM for our purposes because were only measured majors. After accounting for these conditions, there was a sample size of 126. The two key grouping variables we used to test our hypotheses were: minority status, which distinguished between majority students in STEM (those who identified as White or Asian, $n = 109$), and minority students (Black, Latino(a), or Native American students, $n = 17$), and major declaration, which distinguished between those who declared a STEM major ($n = 85$) and those who declared a non-STEM major ($n = 41$) by Wave 6 (the end of sophomore year).

Quantitative Measures

Out of many scales that were used in IPP, we selected four to use in this study, based on their relevance to our four conceptual categories of interest in relation to STEM persistence.

Student Adaptation to College Questionnaire (SACQ; Baker & Siryk, 1984). For a sense of belonging, we used two of the three subscales of the SACQ: social adjustment and feelings of attachment to one's college. Social adjustment was measured with 20 items, e.g. "I am very involved with social activities in college" and "I am adjusting well to college." Attachment was measured with 15 items, e.g. "I expect to stay at this college for a bachelor's degree" and "I enjoy living in a college residence." Participants were asked to rate how well the statements applied to them on a scale of 1-9, with 1 being "Doesn't apply to me at all" and 9 being "Applies very closely to me." This measure was given at Waves 2 and 5 (over winter break freshman and sophomore years). For the current analyses, we used data from Wave 2.

Basic Psychological Needs Scale (BPNS; Deci & Ryan, 2000). This scale is based in self-determination theory, but only the competence subscale was used in this study, as a general indicator of self-efficacy. Participants rated six items such as "People I know tell me I am good at what I do" and "I have been able to learn interesting new skills recently" on a scale of 1 (not true at all) to 7 (very true). This measure was given at every wave except for Wave 1.

Implicit Self-Theory Scale (Dweck, 1999). This scale measures perceptions of the malleability of personality and intelligence, but only the intelligence subscale was used in this study. The intelligence subscale consists of 8 items, e.g. "Your intelligence is something about you that you can't change that much." Participants were asked to rate these statements on a scale of 1 (strongly agree) to 6 (strongly disagree). This measure is particularly important in regards to STEM performance, as having a fixed mindset can be especially discouraging in the STEM fields (Gunderson et al., 2017). This measure was given during Waves 1 and 4 (the summer before freshman year and sophomore fall).

Ethnic Identity Scale (adapted from Phinney's (1992) Multigroup Ethnic Identity Measure; MEIM). This scale included four items from the Multigroup Ethnic Identity Measure (MEIM; Phinney, 1992) such as "I have a clear sense of my ethnic background and what it means for me" and "I think a lot about how my life will be affected by my ethnic group membership." Participants rated these items on a scale of 1 (strongly disagree) to 6 (strongly agree). In this study, this scale will indicate how integrated participants' ethnic identities are, and how much they want to explore them. This measure was given at Waves 2, 3, and 6 (freshman winter and spring of freshman and sophomore year), and we used scores from Wave 2 in the current study.

Narrative Prompts and Coding

Several narrative measures were used in addition to the quantitative measures. The narrative prompts, described below, came from Waves 1, 3, and 5, and were coded for several themes pertaining to belonging and support, academic self-concept, motivations, and identity intersectionality, as summarized in Table 2 (see Appendices A-C for the coding systems used). Three coders worked independently to code the four sets of narratives. Inter-rater reliabilities were calculated, and discrepencies were often discussed and resolved. The reliabilities reported here are the ranges of kappas and intraclass correlation coefficients (ICC), depending on if the variables were binary or categorical (kappa) or continuous (ICC).

Wave 1: Pre-College Questions About Major/Career Choice. These seven questions were asked only in Wave 1, and were developed specifically for IPP. They are a mix of fixed answer (multiple choice) and open-ended responses. After asking what major they are considering and how certain they are of that choice, they are asked if they have an idea for a career path. The narrative question is then posed: "Have there been experiences in your life that have affected your current thinking regarding your major and / or career choice?" The primary information that can be collected from these responses are the participants' motivations for being interested in a certain major/career path.

The coding themes for Wave 1 narratives focused on motivations and influences on pursuing STEM and were rated on a binary scale of 0-1, with 0 being not present and 1 being present. The themes that were present enough to have decent reliabilities were intrinsic motivation--being motivated to pursue a field because of one's own interest (kappa range = .61-.76), following in a family member's footsteps (.70-1.00), getting a degree to increase employment options (.49-.86), communal motivation--wanting to help others, (.64-.91), and having a mentor in a STEM field (.65-.91). Four other themes including family obligation, financial concerns for oneself, financial concerns for one's family, and conflict between intrinsic and extrinsic motivations were coded for but were not very present and therefore yielded poor reliabilities and were excluded from the current analyses.

Wave 3: Academic High Points and Low Points. (adapted from McAdams' (2008) Life Story Interview). This prompt was used in Wave 3, which is freshman spring. Academic high points and low points are emotionally significant experiences that occurred within the past school. An academic high point is characterized as a memory that is extremely positive and meaningful to the participant. A low point is an equivalently important, but extremely negative memory. These must be related to academic life, but could have taken place inside or outside of the classroom. Details about the memory including when it occurred and who was involved were also asked. The participants were also asked if each memory affected their potential major or major choice, and whether they have shared the memory. What was most pertinent to this study was seeing if these memories took place in a STEM class or not. A highly positive STEM memory may indicate high science self-efficacy and science identity, while a high point from a non-STEM class may indicate they enjoy another subject more than STEM. We can then see if interest in a non-STEM field is due to identity conflict or some other reason. A highly negative STEM memory may reveal low self-efficacy for science, or lower sense of belonging in STEM, and predict switching out of STEM.

The high point and low point narratives were coded by the same coding themes, though some themes present in the high points (e.g. self-efficacy) did not appear in the low points and some themes that were in the low points (e.g. doubting ability) did not appear enough to be coded reliably in the high points. The first thing that was coded for was whether or not the memory was from a STEM class, with options being either yes, no, or could not tell, which was counted as “no” for the purposes of these analyses (high point kappas = .64-1.00; low point kappas = .45-.87). Then self-efficacy, or confidence that one can succeed either through talent or hard work, was coded for on a three-point scale, with 1 = not present, 2 = present but not well developed, and 3 = strongly present (high point ICCs = .35-63; low point ICCs = .23-.44). Often a rating of 3 would be distinguished from a rating of 2 if emphasis in the narrative was placed on working hard or making strong efforts to improve. Doubting ability, or feeling inadequate or unable to perform as well as others, was also measured on a three-point scale where 1 = not present, 2 = present but not well developed, and 3 = strongly present (high point ICCs = N/A; low point ICCs = .36-.81). A rating of 3 meant that there was still doubt by the end of the narrative, whereas a rating of 2 meant that there had been doubt, but it had been overcome. Academic support, connectedness, and social belonging was coded for together to represent the 'belonging' category (high point ICCs = .43-.93; low point ICCs = N/A). This was coded on a three-point scale as well, depending on how strongly the theme appeared. Very strong academic support or social belonging meant the narrative included feeling particularly connected to a professor or peers in their field. Lack of academic support was coded for on the same three-point scale, and captured feelings of when students felt they had been wronged by professors or let down by their peers (high point ICCs = N/A; low point ICCs = .49-.89). We also coded for whether the memory had an impact on future major choice or career plans (high point kappas = .65-.81; low point kappas = .43-.56). There were 5 coding options, including no impact, unclear impact, lessening likelihood of a STEM major, increased likelihood of a non-STEM major, or reinforced plans for a STEM major.

The themes that were coded for but not very present in the high points were the presence of science identity, doubting ability, and lack of academic or social support. The themes that were not as present or hard to measure in low points were science identity, and presence of support or belonging. Motivation themes, such as presence of intrinsic and extrinsic motivations, and intersectionality themes, such as whether race or gender were mentioned in the context of STEM or non-STEM, were coded for as well, but came up so infrequently that reliabilities were not calculated, and were excluded from the analyses of the current study.

Wave 5: Anticipation of Major Declaration Questions. These three questions were developed for IPP. These questions were asked at Wave 5 only, or sophomore winter. They asked the participant if they know what major they are going to declare in the spring and what factors have influenced that choice. Explicit questions about how social influences including socioeconomic status, ethnicity, gender, and family financial status have affected the student's major choice are asked. This prompt, so close to when they are going to declare, is meant to measure the motivators and factors influencing their decision-making process, as well as how identity intersectionality factors into this process. In Wave 5, the decision is still being made, and it is the last wave before the choice has been made.

Participants in Wave 5 wrote what major they were considering at the time and the most influential experiences, people, or identity factors that have affected their choice. There were a wide range of topics that could appear in these narratives, so many things were coded for. All reliabilities reported are kappas because there were no continuous variables. Majors being considered (STEM, non-STEM, or both), as well as certainty of these considerations were coded for (kappas = .90-.95 and .67-.82). Whether they evaluated themselves positively in STEM (.46-.49), negatively in STEM (.27-.66), positively in non-STEM (.46-.57) or negatively in non-STEM subjects (not enough data to calculate reliability) were also coded for. Presence of intrinsic motivation in STEM (.78-.81) and non-STEM (.81-.89) was coded for. Lack of or decreasing intrinsic motivation in both STEM and non-STEM was coded for but was not found to be reliable. The extrinsic motivations of following family footsteps (.65-.82), family obligation to do STEM (.23-.42), helping family financially (.44-.69), and personal concerns about hireability in STEM fields (.65-.72), and in non-STEM fields (.42-65) were also coded for. Motivation to help others, or communal motivation, was coded for both STEM and non-STEM fields but were not reliable enough to be included here. Conflicts between intrinsic and extrinsic motivations were coded for but were too infrequent or unreliable to report. Positive experience with a STEM professor (.61-.76), non-STEM professor (.54-.77), and negative experiences with a STEM professor (.65), and non-STEM professors were coded for, and there were too few negative reports of non-STEM professors for reliabilities to be calculated. Having a mentor in STEM was coded for (.50-.81). Identity intersectionality themes were coded for, and the two categories of positive mention of gender in the context of STEM (.66-.82) and integration of race and non-STEM field (.83-.85) came up enough to calculate reliabilities for. Science identity was coded for but, as in Wave 3, it did not appear often enough to calculate a reliability for.

Results

First, we tested to see if the students in traditionally underrepresented groups in our study were indeed underrepresented in STEM major declarations. Table 3 illustrates that race groups underrepresented in STEM at the national level are also underrepresented in STEM in this study: majority (white and Asian) students declared STEM majors at disproportionately higher rates than students of underrepresented race groups ($X^2 = 6.19$, $p < .05$). Specifically, 72% of majority students declared a STEM major, whereas only 41% of minority students did. However, this effect was not present for gender. Men and women declared majors in STEM at a very similar rate ($X^{2.} = .04$, p = ns). We hypothesized many reasons for there to be a discrepency for female participation in STEM, but because we did not find any, we focused our analyses pertaining to explanations for the disparities on students of color from underrepresented groups rather than women.

As shown in Table 4, out of 126 participants, only seven STEM majors were members of underrepresented groups. Only three of these students were women of color. This is important to keep in mind when reading through the rest of the analyses because this makes the sample size for some of our hypotheses-testing categories quite small, which could result in type I or type II errors when analyzing the hypotheses. This is a mark of the severity of the problem of underrepresentation itself: there were hardly even enough people of color in our study to study at all.

We used a series of chi-square analyses and ANOVAs to examine, in a cautious and exploratory manner given the number of minority students in our study, to see if there were significant differences between these groups shown in the factors we measured. The major declaration group is kind of a retrospective variable because participants declared their major after answering all of the narrative prompts and quantitative measures used in these analyses. This variable allowed us to see who persisted in STEM and if there were differences between those who ended up persisting and those who did not. We also examined differences between majority and underrepresented groups and if these differences were interacted with the decision to persist in STEM or not. In order to capture both of these facets of our study, chi-square analyses were done twice for each factor. One way focused on the differences between STEM and non-STEM majors, regardless of race, and then examined the differences between STEM and non-STEM majors separated by majority and underrepresented status. The other way focused on the differences between majority and underrepresented students, regardless of chosen major, and then in addition to that, looked at the differences between majority and underrepresented students separated by major choice. ANOVAs were used to examine the quantitative scale data, and these analyses were also separated by main effects for major group, majority/minority status, and the interaction of these variables.

Belonging, Support, and Mentors

Our hypotheses relating to belonging were that a greater sense of belonging, both socially and academically, would increase persistence for underrepresented students, as would the presence of STEM role models. The narrative data relating to belonging were: presence of STEM mentors provided at Waves 1 and 5, presence of academic and social support in academic high points at Wave 3, lack of academic or social support in academic low points at Wave 3, and positive or negative mention of peers or professors in STEM at Wave 5. The quantitative data meauring belonging were the social adjustment and feelings of attachment to one's college subscales of the SACQ.

Beginning with academic factors, we found that prior to coming to college, 22 majority students (20% of majority students) had had a STEM mentor compared with only one underrepresented student (6% of underrepresented students). This did not yield a significant result in the chi-square analyses (Table 7), but it was approaching significance ($X^2 = 2.02$, $p = .16$). Similarly, there was not a significant difference between majority and minority students mentioning a mentor figure in their Wave 5 narratives about reasons for major choice (Table 7). However, zero underrepresented students mention having a mentor in STEM, compared with 8 majority STEM majors and 1 majority non-STEM major.

There was no difference between mean scores of academic/social support in high point narratives for minority and majority groups, as shown in Table 5. There were also no significant differences between majority and minority students in lack of support found in low points.

Positive evaluation of STEM professors in Wave 5 was brought up more by those who ended up majoring in STEM than those who majored in non-STEM, as shown in Table 6. This applied to both majority and minority students. For majority students, 23% of those who majored in STEM talked positively about a STEM professor compared to just 7% who did not major in

STEM. For underrepresented students mentioning positive experience with a STEM professor, the differnce is 17% for STEM majors and 0% for non-STEM majors. This was approaching significance for underrepresented students, with 17% (just one person) of STEM majors mentioning a STEM professor positively, and zero non-STEM majors mentioning a STEM professor positively. The sample size is so small, as only one minority student (representing 7% of the 14 total minority students at Wave 5) mentioned a positive experience with a STEM professor, that we must be cautious with these analyses. However, this could be indicative of underrepresented students reporting fewer positive experiences with STEM professors which may lead to less persistence in STEM. Majority students were also the only ones out of the STEM majors to talk about a STEM professor in a negative light, but there was one minority student who evalutated a STEM professor negatively and did not major in STEM.

To measure social belonging, we measured positive peer influence in STEM, and found that STEM majors were more likely to bring up positive interactions with peers in a STEM context than non-STEM majors (Table 7). No underrepresented students, either in STEM or non-STEM majors, brought up a positive STEM peer experience, and the chi-square was not calculated because there was no one in that group. This is telling in itself, possibly meaning that underrepresented students have fewer social connections revolving around their STEM classes than majority students. From the social adjustment subscale of the SACQ, we found there was no difference between majority and minority groups in social adjustment ($F = .10$, p = ns), nor was there an interaction between those groups and STEM major versus non-STEM major groups ($F = .07$, p = ns). Incidentally, there was a marginally significant main effect of STEM major declaration on social adjustment ($F = 3.78$, $p = .055$), meaning that the less socially adjusted students declared STEM majors, regardless of race.

Though our belonging hypotheses were not supported by traditional means, this was partly due to the fact that no underrepresented students mentioned positive academic or social belonging. Majority students felt more academically and socially supported in STEM, and reported having STEM mentors, whereas underrepresented students did not. Thus, these differences may have an impact on choosing a STEM major that was hidden in our study due to sample size issues.

Academic Self-Concept and Self-Efficacy

Several aspects of academic self-concept were assessed at Wave 3, by coding for self-efficacy, science identity, and doubting ability in academic high points and low points, as well as whether the high points and low points themselves were STEM-related. Additionally, we looked at positive and negative self-evaluations in STEM as a factor in making a major choice at Wave 5. The competence subscale of the BPNS at Waves 3 and 4 and the IST intelligence subscale at Waves 1 and 4 were also used.

We had predicted underrepresented students would have lower self-efficacy in STEM, and that this would be associated with declaring a non-STEM major. Counter to this prediction, however, underrepresented students who went on to major in STEM had the lowest self-efficacy in the low point narratives out of majority students and underrepresented non-STEM majors (see Table 5; Figure 1). This was true even when controlling for whether the narrative was STEM-related. Underrepresented students also reported a lower general competence self-evaluation in the competence subscale of the BPNS at Wave 3 (see Table 9; $F = 5.68$, $p < .05$; $M_{Majority} = 5.02$, $M_{Underrepresented} = 4.28$). There was no interaction effect for STEM major ($F = .46$, $p =$ n.s.), meaning underrepresented students reported lower perceived competency than majority students in general and not just in STEM. The same effect was found again at Wave 4, but with only marginal significance (F = 2.81, p = .10; $M_{Majority}$ = 4.88 and $M_{Underrepresented}$ = 4.38). It is an important finding to keep in mind when considering self-efficacy and belongingness for underrepresented students at college as a whole. It is also interesting to note that this effect was weaker when tested the following semester, suggesting there could be a longer period of adjustment. While there were significant findings relating to self-efficacy in low points, there were no differences between groups for doubting ability in academic low point narratives, as shown in Table 5.

Those who persisted in STEM were more likely to have reported a STEM related high point, as shown in Table 8. Ignoring minority status, 47% of STEM persisters had a STEM related high point versus 15% of non-STEM majors. Among STEM persisters, however, majority STEM persisters (57%) were more likely to have a STEM related high point than underrepresented STEM persisters (14%; see Table 8 for X^2).

At Wave 5, majority students reported more positive self-evaluations in STEM than underrepresented students, supporting the hypothesis that (see Table 6). In fact, zero underrepresented students, from either STEM or non-STEM majors, reported a positive self-evaluation in STEM. One underrepresented student brought up a negative self-evaluation in STEM, and this was someone who did not choose a STEM major. However, because no majority students who did not major in STEM brought this up, there was a marginally significant difference between these groups, as shown in Table 6, and this finding supports our hypothesis in that it shows a negative self-evaluation can lead to not persisting for underrepresented students.

We had also hypothesized that higher self-efficacy would be related to higher science identity, and this would predict STEM persistence for all groups. Due to the lack of responses mentioning science identity at all, this hypothesis was impossible to test and not supported by the data. Though we did not explicitly state hypotheses about this, we used the IST scale to see if levels of fixed and growth mindsets differed between the groups in our study. We found that underrepresented students had a higher score on the IST, meaning they generally had more growth-oriented mindsets ($F = 7.75$, $p < .05$) at Wave 1. However, by Wave 4, this difference was gone ($F = .16$, $p =$ n.s.).

Motivations for Pursuing STEM

With respect to STEM-related motivations, we first hypothesized that intrinsic motivation would predict STEM persistence for all groups. Intrinsic motivation in STEM was measured in Waves 1 and 5. The data from Wave 1, as shown in Table 7, reveals a difference in levels of intrinsic motivation between majority and underrepresented students both overall, and who would go on to major in STEM. For underrepresented students who persisted in STEM, 29% reported intrinsic motivation in STEM at Wave 1, compared to 71% of the majority students who persisted in STEM. By Wave 5, however, the levels of intrinsic motivation were split in the way we had predicted. Intrinsic motivation as it was reported by 87% of STEM majors and only 19% of non-STEM majors, with consistent findings for all race groups. This supports our hypothesis that intrinsic motivation predicted STEM persistence for all groups. As shown in Table 6, students majoring in non-STEM were also more intrinsically motivated in non-STEM (89% of who reported intrinsic interest in non-STEM) than STEM majors (25% of who reported intrinsic interest in non-STEM subjects). This indicates that there was a lack of conflict between intrinsic motivations for both STEM and non-STEM classes. Because there was a difference between race groups at Wave 1 but not Wave 5, there might have been an increase in intrinsic motivation in STEM for underrepresented students in the time between Waves 1 and 5.

Extrinsic motivations measured at Wave 1 were: following in one's family's footsteps, employment concerns, which includes wanting to make money for oneself, one's family, or just to increase one's hirability, and communal motivations, or being motivated to help others. At Wave 5, the extrinsic motivations of following family footsteps, feeling obligated to one's family to major in STEM, wanting to help one's family financially, and wanting to increase one's hirability. We had predicted that external motivations would be brought up more by underrepresented students. We thought that presence of communal and familial motivations, however, while external, would not lower STEM persistence.

For Wave 1 themes, as shown in Table 7, there was a marginal difference between majority and underrepresented students in the STEM persistence group for amount employment concerns were brought up ($X^2 = 2.61$, $p = .10$). Among STEM persisters, 29% of underrepresented students brought up employment concerns compared to 9% of majority students. There was also a marginally significant difference STEM persisters and non-STEM majors in the underrepresented group ($X = 3.24$, $p = .07$). This is the same 29% of underrepresented students who had employment concerns, which is being compared to the group of underrepresented students of non-STEM majors, zero of who reported employment concerns. This means employment concerns, but not the other types of extrinsic motivations seem to have been present for a greater proportion of underrepresented students than majority students, but this did not affect STEM persistence, as the only underrepresented students who brought this up did persist in STEM.

As for the motivations examined in Wave 5, only the motivations of family footsteps and hirability categories revealed significant differences between groups. Both underrepresented and majority STEM persisters were more likely to be following in their family's footsteps than non-

STEM majors (22% for persisters and 6% for non-STEM majors; see Table 6). Hirability was brought up by both majority and underrepresented students by STEM persisters. For STEM persisters, 33% mentioned hirability compared to 3% of non-STEM majors. Both of these effects of motivators at Wave 5 did not follow with our hypothesis that they would be brought up more by underrepresented students, and it turns out that these motivations were often brought up by STEM persisters, showing that they did not deter students from majoring in STEM.

Identity Intersectionality—Race, Gender, and STEM

Identity intserectionality was measured through the ethnic identity scale at Wave 2, and in narrative measures at Wave 5. The Wave 5 measures include gender and STEM integration, meaning that they felt empowered to pursue STEM because of their gender, and race and non-STEM integration, meaning they felt their race was a reason they wanted to pursue a non-STEM field. We had hypothesized that identity intersectionality themes would be brought up more by underrepresented students, that conflict between gender identity or ethnic identity and STEM would be associated with majoring in non-STEM, and that integrating those identities with STEM would be associated with persistence. We also predicted gender and ethnic identity integration without science identity integration would increase interest in a non-STEM field and lead to a non-STEM major.

Because of the lack of evidence for a gender disparity in STEM in our study, there was not enough gender-STEM identity conflict to analyze, meaning that this part of our hypothesis was wrong. In fact, 11% of all students reported gender-STEM integration, though these were only majority students, as zero underrepresented students reported this. Only one underrepresented student reported race and non-STEM integration as well, and there were no significant differences between majority and underrepresented groups and STEM persistence for this category.

The ethnic identity scale, measuring exploration and commitment to an ethnic identity, was scored higher by underrepresented students (M = 4.11) than majority students (M = 3.36) in general, as shown in Table 9. This was a significant difference, but did not have an impact on STEM persistence. Overall, we did not expect some of the findings that we found in the identity intersectionality analyses, but this may be due to limitations in the design of IPP such that the narrative prompts did not necessarily encourage a lot of reflection on gender or race, as well as the limitation of low sample size of underrepresented students. We did find that many women wanted to pursue STEM in spite of women generally being underrepresented in the field, and that these women were all either Asian or white, rather than from an underrepresented ethnic group.

Discussion

Our study found evidence to support the STEM-gap problem for underrepresented ethnic minorities in STEM, but not for women. The findings with the largest significant effects in this study were differences in the academic self-concept of majority and underrepresented students. The lowest rating of self-efficacy in Wave 3 low point narratives came from the underrepresented students who persisted in STEM (figure 1). Though underrepresented students did report some positive experiences in STEM, no underrepresented students evaluated themselves positively in STEM in their Wave 5 narratives. Additionally, no underrepresented students mentioned having a STEM mentor at Wave 5, and only one underrepresented student brought up a STEM mentor at Wave 1. Three students in all race groups mentioned an integration of their race and STEM field, but these were all either white or Asian students, and not members of underrepresented minorities.

Our findings paint a more positive picture for women than people of color at college. The STEM gap problem was not found for women, as they persisted in STEM at the same rate as men, and we did not run many statistical analyses between men and women because of this. Some women integrated their gender and science identities, saying that they were proud to be a woman scientist because of the gender disparity that exists in STEM. I would have been curious to know if these women who felt comfortable majoring in STEM had experienced any issues like microaggressions and if they progressed in spite of those experiences, or if they had never had those experiences. Hearing whether or not they felt underrepresented would be valuable as well, because it has been shown that being aware of underrepresentation can hurt performance, while being told of equal representation can boost performance. Future studies looking more specifically at these issues could possibly determine the importance of such things.

However, it is also important to note that the women who reported gender integration with STEM were from the majority group, and this reinforces the finding of the double bind for women of color in STEM. A Mexican/Arab woman brought this up explicitly in her Wave 5 narrative: “I get treated much worse than white women at this school.” She did not elaborate about that specifically in Wave 5, but her Wave 3 low point narrative was about a microaggression she faced from her English professor:

“[My English] professor made me feel unintelligent… When I read the book title and author of one of the readings we were going to do off the syllabus, I said it incorrectly and was immediately corrected (it was Greek based). The girl that read next didn’t trip over her words even though she had many more book titles and unique author names to get through; the professor complimented her on being able to read them all when she was done. The fact that she felt like she needed to compliment her for not messing the names up gave me the impression that my mess up was huge; even though it was not my fault that I was never exposed to any of those authors in high school, while the girl that did was. It made me feel inferior because I didn't have the cultural capital that others did, clearly."

While this event did not take place in a STEM class, it is an example of how students with different high school education (usually a result of different socioeconomic backgrounds) at college can be made to feel unintelligent, or like they do not belong, influencing both their sense of belongingness and self-efficacy. A similar sentiment that was shared by a Latino male student, who said in his academic low point, "it was more than the difficulty of [physics] that turned me away, it was the overall sense that they only wanted people who were already comfortable with physics." These narratives both contain the underlying issue of socioeconomic status that was not analyzed in this study, but has been shown in other literature to play a role in STEM-minority status (MacPhee et al., 2013). MacPhee and colleagues (2013) found that lower socioeconomic status was especially an issue for students who had another STEM minority status (either being a woman or being part of an underrepresented group). Disparities in cultural capital, as described in the narrative about Greek author names, is an elegant summary of the problems that some professors can accentuate if they are not being accommodating of these differences. This problem illustrates the problem of the self-perpetuating STEM pipeline, where students who have more previous knowledge in STEM when arriving at college are given an advantage that makes them more likely to pursue STEM than those who did not learn as much science in high school.

This idea of compounded stressors that reduce STEM persistence may be stretched to include challenges like mental health problems. These problems may be more of a problem for underrepresented students in a way they might not for majority students. When one Mexican/Arab female student realized they could switch away from STEM said, “I realized I could just focus on history of art and stop killing myself through a natural science major (literally, I was so depressed and suicidal)… being in that classroom environment, like STEM, felt awful, alienating, and kicked up my anxiety.” Having mental health issues, which could either be exacerbated by alienation in STEM, and also cause further struggles in STEM, which also coincide with struggling with gender, racial, and socioeconomic differences to the majority of students in STEM may have created an environment that was particularly toxic for this individual due to their particular multiple-minority status.

She certainly felt that her concerns were not being taken seriously because of her minority status: “My disability [ADHD], as a POC [person of color], is seen as a ploy to get more benefits, much like the way people think that people abuse the welfare system.” This implied that racial and class prejudices were behind the lack of support from faculty and the administration. She felt disenfranchised as a female student in STEM: “I’m a woman so people constantly talk down to me in the sciences/maths, don’t listen to me, don’t take my suggestions (even when they’re correct/helpful), until they hear it from someone they respect more.” This is an example of negative peer interactions based on gender identity, which is something that did not come up very often in our study, but is nonetheless a real problem for women in STEM.

This student also mentioned coming from an underprivileged financial background, meaning that they were not privy to the elementary and high school educations that many of their peers at Haverford did have access to. As she said, this meant a lack of cultural capital that others had, which culminated in the Greek author microaggression, as described in her academic low point from Wave 3. In addition to this behavior from her professors, she noted a lack of support from deans, who are supposed to be there to help students navigate issues with their academics and professors:

"People kept discouraging me (professors! deans! etc) and telling me I should take time or basically that considering my situation I would most likely be unsuccessful as a chemistry major. So I left because I wanted to preserve my health, and I know I couldn't do that (all by myself, because I have literally no one to advocate for me) simultaneously."

She ended up majoring in history of art, after having had such a bad experience in STEM due to inadequate mental health accommodations and support from peers, professors, and administrators. She noted that there was a noticeable lack of someone to advocate for her, meaning she thought more could have been done to help a student like her from an underprivileged background who was struggling to catch up. During Wave 3, this student had been set on doing a science major after, but at Wave 5, she had switched to wanting to be an art history major. This was due at least partly to the lack of respect at the institutional level for her mental health and racial and gender identities. While this issue should be taken seriously, it should also be noted that this student was one of the only ones in this study to bring up these issues of discrimination so explicitly. All underrepresented STEM majors at Wave 5 did not mention anything bad about a STEM professor, and of the non-STEM majors, she was the only one to criticize a STEM professor. This means for many underrepresented students, there are not necessarily such strong negative feelings towards the college or the STEM department. That does not mean her experiences should not be taken seriously or do not present serious concerns for the way elite institutions handle diversity as a whole. Rather than invalidating the experiences of this one student, the disparity in discrimination between her and other underrepresented students is evidence that there are a multitude of experiences, especially among this group of "underrepresented minorities" that was artificially created for the purposes of this study. Just because they are all underrepresented in STEM does not mean they share the same feelings or experiences in STEM, and though extremely negative experiences were only reported by 7% of the underrepresented sample, they are real issues that deserve to be addressed.

This study also did not take into account lesbian, gay, bisexual, or transgender (LGBT) students, who are minorities in general both on campuses and in the wider world. Because of this, they may face similar belongingness issues due to the simple fact of underrepresentation and possible exposure to things like microaggressions. Admittedly, this study was already so full of variables and groups that it may have been too much to add the components of sexual orientations and non-binary genders to our analyses, but LGBT representation may be something that future studies should look into, including whether or not they feel the same belonging uncertainty as other minority groups are at risk to.

It turned out that of the seven underrepresented students who persisted in STEM, five were black, and of the ten who did not persist, eight were Latino. This finding was surprising but may have some grounding in previous literature. Hazari and colleagues (2013)[b] found that Latina women reported lowest self-efficacy out of men and women of other ethnicities. In addition, black women are expected to have higher self-esteem and independence (Hanson, 2004). These findings, while only focused on women, may help explain the disparity in this study that African American students were more likely to persist in STEM, and Latino students were more like to switch out. For this study, there were probably not enough Latino or African American students to compare the belongingness or self-efficacy of those groups, but future studies could see if this finding is found at other institutions, which could inform what interventions should focus on.

Many of the self-efficacy and belonging issues reported came from the group that persisted in STEM, which seems to contradict our hypotheses. It may be that this was a self-selecting group of students who wished to pursue STEM because of their inherent interest in it, and reported low self-efficacy in STEM because it something that they care about and is central to their identity. If STEM is more central to their identity, they may be more emotionally affected by their successes or failures in STEM than students whose interests switched away from STEM soon after coming to college. Those who dropped STEM may not have been as bothered by belongness or self-efficacy issues within STEM once they decided to drop it, as they may have distanced themselves from it to adapt to their change of mind. Another view of this finding is that sticking with STEM is the cause of a lower self-efficacy, rather than being the result of lower self-efficacy. It could be that the students who decided to drop STEM have not had as many low points because of the lack of STEM in their schedules. Nevertheless, it is somewhat concerning that the underrepresented STEM persisters had the lowest self-efficacy in our study, as this could mean they may be most likely to encounter difficulty in STEM later on in their STEM careers.

The lack of science identity found in our study may be a result of the fact that the identity college students' identities are still developing. It may also be due to the fact that the college used was a liberal arts school where students are encouraged, and even required, to take classes in many disciplines and fields, possibly reducing the amount of strong attachment one might otherwise feel to a specific department.

Because of the nature of IPP, i.e. the open narrative questions that asked students to reflect on how their experiences affected them, self-efficacy naturally came up often, but things like identity conflicts did not come up as much. There were a few things we had hypothesized about but did not come up enough to report reliable statistics for (family obligation, gender-STEM conflict, and race-STEM and non-STEM conflicts). However, some students did bring up these issues very specifically and the fact they were not mentioned very often may simply be a mark of our low sample of underrepresented students. For example, an African American woman who persisted in STEM said, “I come from a very interdependent and community based culture where parents are highly revered, so I feel myself compelled to give into the wishes of my mom.” Her mother’s wishes led to her feeling obligated to majoring in STEM. While this theme did not come up very often, it is still present and should not be dismissed just because of its low frequency.

Though we expected to find, and did find, some differences between race groups in our study, there were also similarities that importantly seem to be factors that increase STEM persistence for any group. Underrepresented students brought up many positive experiences, including getting support from STEM professors, having intrinsic motivation to pursue STEM, and following in a family member’s footsteps came up often in those who persisted in STEM. An African American male student, brought up support from a professor: “a math professor at Haverford College has been very nurturing to me, and has encouraged me to pursue math farther… I was even able to do research with her last summer.” This student persisted in STEM, and this narrative reinforces the importance of having a STEM mentor and academic support in STEM. Another similarity between majority and underrepresented students’ narratives was the focus on intrinsic motivation. An African American male student, brought up classic intrinsic motivation for pursuing STEM: "I have loved the stars and the universe since I was a kid… It [physics and astronomy] resonates with my way of thought and perceiving daily life." Strong intrinsic motivations came up very often for both majority and underrepresented students, and often came up for those who persisted in STEM (as indicated by the results on Table 6). We also found wanting to follow in family footsteps in underrepresented narratives. One male student identifying as both African American and white mentioned: "My father is a doctor… growing up watching what he does… it looks like more fun than work." It is important to note that someone with a family member who has a successful career in STEM is likely to also have a achieved certain level of socioeconomic status, meaning they may be free of some of the stressors of other students who are the minority in STEM. Nevertheless, this cheerful outlook on STEM is not absent from the narratives of underrepresented students, and this means that not all is doom and gloom for all underrepresented students in STEM.

We found an effect similar to Syed's (2010) finding that connecting one's racial identity to a non-STEM class may decrease interest in STEM. One underrepresented student who majored in Spanish said, "Being Mexican-American has had considerable influence on my major choice." He also said, "There is no department quite like it [the Spanish department] in the Bi-Co." This is not elaborated on, but it sounds as though he felt a special connection to the Spanish department because of his ethnic identity that increased his sense of belonging within that department, as it may not have done in other (including STEM) departments.

We took a broad approach to the issue of underrepresentation in STEM, and even with all the factors we examined, there were some things that are conspicuously missing. More outreach to student groups on campus that are focused on women and people of color in STEM could have been another useful measure of belongingness, and the leaders of these groups may have been able to share some valuable insight on what it is like to be a woman or person of color in STEM. In a similar vein, further research could oversample even more for underrepresented students to produce a larger sample size so that more statistically powerful effects could be observed.

This data had already been collected when it was decided to be used to examine STEM participation. It was very convenient that we had data that was already collected to be analyzed for the purpose of this study. Due to the practical limitations of working on an undergraduate thesis, it would not have been feasible to get a longitudinal study up and running with the breadth that IPP had already established. However, I think it is a limitation that there were no narrative prompts regarding race primarily written or written in collaboration with people of color. Because ethnic identity was not necessarily a focus of IPP when it was created, this is understandable, but I think a person of color may have been able to share insight about the most useful things to study with the end goal of improving the experiences of students of color in STEM. Some questions that more pointedly asked if students had faced racism or sexism in STEM would have been some useful data that could have informed us about the more systemic issues that the participants may or may not have encountered. The narrative data, while very useful, still only paints the broad strokes of one's experiences, and may very well leave out things like microaggressions, a ubiquitous form of racism and sexism that is likely to occur in a STEM classroom.

In the end, though some of our hypotheses were not supported by the evidence, there were some important findings that did reinforce previous findings in literature. African American, Latino, and Native American students who expressed interest in STEM upon entering college were found to be less likely to major in the sciences at Haverford, although women were not. Underrepresented students who persisted in STEM were found to have a lower self-efficacy rating than other groups in the study. Intrinsic motivation was important for all students. Extrinsic motivations were not all associated with minority status, as we had been predicted. Further efforts to improve representation in STEM could include looking into providing more support for students, especially those with multiple levels of STEM minority status, which would include gender and race, but also mental health and socioeconomic status. It should also be noted that STEM was not the only area where these issues with identity cropped up, indicating that this may be a general problem in any field at colleges where professors, deans, and other students are not be accomodating to the fact that some students are from less privileged backgrounds than others.

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Table 1

Time Periods For Waves 1-6

Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6
Summer before freshman year	Winter of freshman year	Spring of freshman year	Fall of sophomore year	Winter of sophomore year	Spring of sophomore year

Table 2

Narrative Measures and Coding Themes

	Wave 1	Wave 3	Wave 5
Narrative prompt	Pre-College Questions	Academic High Point and Low Point (HP/LP)	Anticipation of Major Declaration Questions
Coding themes	Motivations: intrinsic, extrinsic (outside pressure, financial concerns, helping others)	Belonging and support, self-efficacy, doubting ability, impact on future plans – STEM and non-STEM	Motivations, social and academic belonging Integration or conflict among identities Influence of professors and mentors Positive and negative self-evaluation

Table 3

Frequencies by Major Declaration and Minority/Majority Group

		Majority or Minority Group		Total
		Majority	Minority	
Major Declaration in Wave 6	STEM	78	7	85
	Non-STEM	31	10	41
Total		109	17	126

Table 4

Frequencies by Major Declaration and Gender

		Gender		Total
		Male	Female	
Major Declaration in Wave 6	STEM	31	55	86
	Non-STEM	17	24	41
Total		48	79	127

Table 5

ANOVA Results for Themes in Wave 3 High Points and Low Points

		STEM/non-STEM Major			Majority/Minority			Interaction
		F-Value	Mean *for STEM Major*	Mean *for Non-STEM Major*	*F*-Value	Mean *for Majority*	Mean *for Minority*	*F*-Value
High Point	Self-efficacy	.20	2.09	2.17	.00	2.13	2.13	1.04
	Support	.00	1.63	1.64	.16	1.67	1.59	2.36
Low Point	Self-efficacy	2.79	1.23	1.50	.03	1.35	1.38	9.13**
	Lack of Support	1.29	1.77	1.53	.99	1.55	1.75	1.65
	Doubting Ability	1.193	2.04	1.81	.15	1.96	1.88	2.11

* = *p < .05*
** = *p < .01*

Table 6

Chi-Square Results for Wave 5 Major Choice Themes by Minority vs. Majority Group and by STEM Major vs. non-STEM Major Declared at Wave 6

	Majority vs. Minority Group			STEM Major vs. Non-STEM Major		
STEM Major Themes	Total	STEM Major (*n* = *85)*	Non-STEM Major (*n* = 41)	Total	Majority (*n* = 109)	Minority (*n* = 17)
Positive Self-Eval STEM	4.14*	2.65	.29	10.23*	8.64**	--
Negative Self-Eval STEM	.00	.65	3.47+	1.41	2.87+	.80
Positive Self-Eval Non-STEM	.01	.66	.04	6.54*	5.32*	1.75
Intrinsic STEM	1.62	.99	.32	48.89**	37.59**	10.50**
Intrinsic Non-STEM	.87	.24	.02	40.20**	32.82**	7.02**
Pos Professor STEM	1.1	.12	.61	4.90*	3.29	1.44
Neg Professor STEM	.11	.46	3.73+	.74	2.18	.81
Pos Professor Non-STEM	.31	.56	.32	3.18+	3.08+	.81
Familial Obligation	.11	.07	.23	.55	.66	.05
Family Footsteps	.08	.45	.61	4.90*	2.85+	3.11+
Family Financial	.11	.07	.23	.55	.66	.05
Positive Peer STEM	2.29	1.34	.29	4.59*	3.68+	--
Hireability STEM	2.32	.78	.29	12.43**	9.93**	1.44
Hireability Non-STEM	.21	.36	.05	7.34**	5.39*	1.75

STEM Mentor	1.4	.77	.29	1.99	1.48	--
Integration: Gender STEM	1.92	.77	1.29	.01	.15	--
Integration: Race Non-STEM	.27	.09	.02	5.50*	4.41*	.81

*** $p < .01$; * $p<.05$; + $p < .10$.*

Table 7

Chi-Squares for the Presence of Themes in Wave 1 Separated by Minority/Majority Group and STEM Major/non-STEM Majors

	Majority vs. Minority Group			STEM Major vs. Non-STEM Major		
STEM Major Themes	Total	STEM Major (*n* = *85)*	Non-STEM Major (*n* = 41)	Total	Majority (*n* = 109)	Minority (*n* = 17)
Intrinsic Motivation	6.31*	5.12*	.992	2.12	1.55	.24
Family Footsteps	.42	.11	1.43	.02	.16	1.52
Employment Concerns	.23	2.61+	.68	1.13	.19	3.24++
Communal Motivation	.02	1.15	.23	2.06	.88	2.47
Mentor	2.02	1.77	.47	.06	.02	.74

* = *p* < .05, + *p* = .106, ++ *p* = .07

Table 8

Chi-Square Results for Wave 3 Academic Low Points and High Points by Minority vs. Majority Groups and by STEM Major vs. Non-STEM Major Decision

	Majority vs. Minority Group			STEM Major vs. Non-STEM Major		
STEM Major Themes	Total	STEM Major (n = 85)	Non-STEM Major (n = 41)	Total	Majority (n = 109)	Minority (n = 17)
High Points						
STEM Event	.07	4.73*	1.89	9.76*	4.04*	11.43*
Impact: Reinforce STEM	2.02	.54	.33	10.19*	7.73*	1.52
Impact: Positive Non-STEM	.014	.79	.018	9.89*	7.79*	2.55
Low Points						
STEM Event	.13	1.17	2.33	.11	.26	3.23+
Impact: Reinforce STEM	3.52+	2.01	1.64	.00	.11	.02
Impact: Lowers STEM	.76	.04	2.35	.73	2.14	1.22

* = *p* < *.05*, + = *p* < *.10.*

Table 9

ANOVA Results for Quantitative Scale Measures

		STEM/non-STEM Major			Majority/Minority			Interaction
	Wave	*F*-Value	Mean *for STEM Major*	Mean *for Non-STEM Major*	*F*-Value	Mean *for Majority*	Mean *for Minority*	*F*-Value
SACQ	2	7.27**	-.30	.44	.05	.10	.04	.94
BPNS	3	1.29	4.48	4.83	5.68*	5.02	4.28	.46
	4	.06	4.59	4.67	2.81+	4.88	4.38	.04
IST	1	.09	4.18	4.27	7.75**	3.80	4.65	.53
	4	.102	3.67	3.77	.16	3.78	3.66	.14
Ethnic Identity Scale	2	1.48	3.97	3.50	3.88*	3.36	4.11	.09

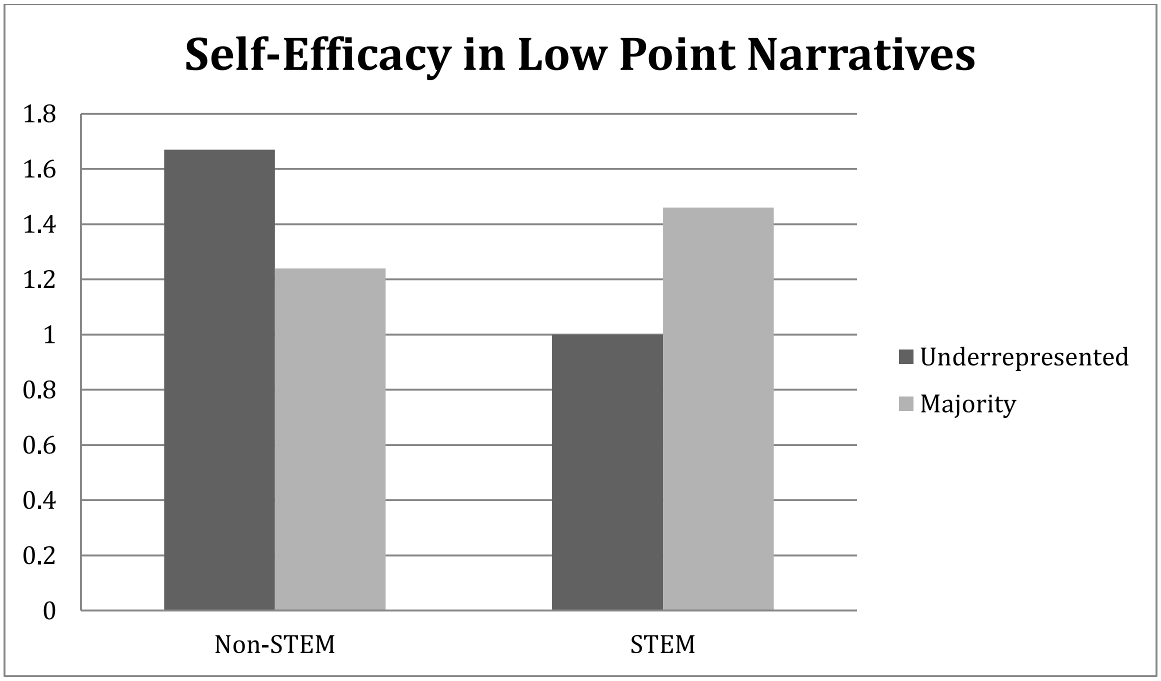
* = $p < .05$
** = $p < .01$
\+ = p <.10

SACQ—Student Adaptation to College Questionnaire- social adjustment and attachment to college subscales

BPNS—Basic Psychological Needs Scale- competence subscale

IST Scale—Implicit Self-Theory Scale- intelligence subscale

Figure 1


Self-Efficacy in Low Point Narratives
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Non-STEM
STEM
Underrepresented
Majority

Appendix A: Wave 1 Coding System for STEM Motivations

All the different forms of motivation/reasons for pursuing a STEM major listed below should be coded on a 0/1 basis where 0 = not present and 1 = present. As much as is possible, only code as present to the extent that they are talking about this motivation or reason in relation to pursuing a STEM major/career.

A. Intrinsic motivation – enjoyment, intrinsic interest, loved it since a young age, etc.
B. Following in family footsteps – doing something because family members do it (but not necessarily because one's family expects them to.
C. Family obligation / expectation – pursuing STEM because one feels obligated to or because one's family expects them to.
D. Financial concerns – need to support family
E. Financial concerns – desire to make a lot of money / a good living
F. Concerns about getting a job (not necessarily explicitly linked to financial concerns; general hirability)
G. Acknowledgment of potential conflict between extrinsic pressure to pursue STEM and intrinsic desire to pursue something else
H. Communal motivation – motivated to pursue STEM to help people
I. Teacher/Mentor/Role Model (non-family)

Appendix B: Wave 3 Coding System for Academic High Points and Low Points

A. STEM-related experience? Is the HP/LP something that happened in a STEM class or directly related to the pursuit of a STEM major/career?

1 = Yes, STEM-related
2 = No, not STEM-related
3 = Cannot tell from narrative whether or not HP/LP is STEM-related

B. Self-efficacy: HP/LP narrative emphasizes believing in one's ability to succeed, especially through one's own hard work and effort. When one's grade validates one's ability to succeed, that could be a 2, but a 3 should explicitly tie effort and hard work to a positive evaluation of one's ability to succeed. This could come in the form of a lesson learned from an experience, which provides a sense of efficacy moving forward (e.g., "I just know that I need to study harder now.")

1 = Theme not present
2 = Theme minimally present or implied, not fully developed
3 = Self-efficacy is a strong theme of the narrative

D. Science identity: the HP/LP narrative includes the presence of a science/STEM-related sense of identity.

1 = Theme not present
2 = Theme is present

E. Doubting/questioning one's ability: The HP/LP narrative includes doubting and questioning of ability. If this is described as temporary but has been overcome or is implied, then give it a rating of 2. If the student explicitly describes active, ongoing doubts in the present (e.g., I doubt my ability to success in college), this is a 2 or 3 depending on how strongly worded and central it seems to the person's current self-view.

1 = Theme not present
2 = Theme minimally present or implied, not very developed or is described as temporary (doubts were present that have been overcome)
3 = Doubting/questioning one's ability is a strong/central theme of the narrative

G. Academic support/connectedness/social belonging – help or praise from professor, positive experience of working with peers / academic support from peers/feelings of connection, belonging with fellow students

1 = Theme not present
2 = Theme minimally present or implied, not fully developed
3 = Presence of support/connectedness is a strong theme of the narrative

H. Lack of academic support/connectedness/social belonging – narrative mentions lack of support from professor, lack of connection with peers in classes, feelings of alienation in academic setting, low sense of belonging in academic settings

1 = Theme not present

2 = Theme minimally present or implied, not fully developed
3 = Lack of support/connectedness is a strong theme of the narrative

I. Impact on major choice/career plans

0 = No impact on major choice/career plans
1 = Person connected experience to lessening likelihood of pursuing STEM (i.e., a negative STEM experience reducing interest or weakening plans)
2 = Person connects experience to greater likelihood of pursuing a non-STEM major (i.e., greater positive interest in a non-STEM field)
3 = Experience reinforces STEM major plans
4 = There is impact on major/career, but cannot tell whether STEM or not

J. STEM motivation themes: For the following motivational themes, code a 1 if present and 0 if absent. Note that these are for motivations specifically pertaining to the pursuit of a STEM major/STEM career.

A. Presence of intrinsic interest in STEM field
B. Lack of intrinsic interest in STEM field
C. Family obligation/family expectations
D. Financial concerns – need to support family
E. Financial concerns – desire to make a lot of money
F. Acknowledgement of conflict between lack of intrinsic interest in STEM and external demands to pursue STEM

K. Identity intersectionality: For the following identity intersectional themes, code 1 if present and 0 of absent.

A. Positive mention of gender in context of STEM
B. Negative mention of gender in context of STEM
C. Positive mention of race/ethnicity/cultural background in context of STEM
D. Negative mention of race/ethnicity/cultural background in context of STEM
E. Positive mention of gender in context of non-STEM field
F. Positive mention of race/ethnicity/cultural background in context of non-STEM field

Appendix C: Wave 5 Coding System for Factors Affecting Major Choice

I. **Intended Major**

A. First, code what is written for intended major on the following options:

1 = Listed STEM possibilities only

2 = Considering STEM and non-STEM

3 = Listed non-STEM possibilities only

B. Second, code which of the following reflects their current state:

1 = Certain about major choice – one major is listed, set on it

2 = Not entirely sure yet – more than one is listed or mentioned in answers, still debating

II. Influential Factors / Motivations: Code each theme listed below for presence vs. absence on a 0/1 scale, across all of a person's answers.

A. Self-evaluation of Performance/Ability
  1. Positive evaluation in STEM
  2. Negative evaluation in STEM (including sense of low belonging based on poor performance)
  3. Positive evaluation in non-STEM
  4. Negative evaluation in non-STEM

B. Science identity

C. Intrinsic Motivation / interest, enjoyment
  1. Presence/increase in STEM
  2. Absence/decrease in STEM
  3. Presence/increase in non-STEM
  4. Absence/decrease in non-STEM

D. Influence of professors
  1. Presence of positive influence (support, inspiration, effecting teaching, etc.) from STEM professors
  2. Lack of positive influence/presence of negative influence from STEM professors
  3. Presence of positive influence from non-STEM professors
  4. Lack of positive influence/presence of negative influence from non-STEM professors

E. Influence of family on STEM pursuit
  1. Following in family footsteps – parents as STEM role models
  2. Fulfilling sense of obligation to family / meeting family expectations
  3. Financial status of family – concerned about making money

F. Peer support/belonging (experience with other students in classes – support, connectedness, sensing of fitting in, etc.)
    1. Positive peer influence in STEM
    2. Negative peer influence in STEM
    3. Positive peer influence in non-STEM
    4. Negative peer influence in non-STEM

G. Non-financial/family career concerns pertaining to STEM
    1. Job concerns /hirability (practical perspective) – reason for STEM
    2. Job concerns/hirability (practical perspective) – reason for non-STEM
    3. Communal goals – reason for majoring in STEM
    4. Communal goals – reason for majoring in non-STEM

H. Different kinds of conflicts
    1. Intrinsic vs. extrinsic – enjoys STEM but external factors (e.g., lack of support from professors) make it a less attractive option
    2. Intrinsic vs. extrinsic – does not enjoy STEM but feels obligated for extrinsic reasons (family, money, practicality, etc.)
    3. Intrinsic vs. intrinsic – enjoys STEM but enjoys other fields as well – torn internally

<u>III. Identity intersectionality</u>: Focus on answers to the last question and code for the following themes.

1. Conflict between gender and STEM associated with not majoring in STEM
2. Integration between gender and STEM (e.g., wanting to be a woman in science) associated with majoring in STEM
3. Conflict between race/cultural background/ethnicity and STEM associated with not majoring in STEM
4. Integration between race/cultural background/ethnicity and STEM associated with majoring in STEM
5. Integration between gender and non-STEM associated with majoring in non-STEM
6. Integration between race/cultural background/ethnicity and non-STEM associated with majoring in non-STEM

<u>IV. Influence of High School (school culture/teachers, etc.)</u>

1. Positive influence on STEM path – reason for majoring in STEM
2. Negative influence on STEM path – wasn't prepared enough, couldn't succeed in STEM in college – reason for not majoring in STEM
3. High School too STEM focused or student too STEM focused in high school – college broadened perspective to other possibilities – reason for not majoring in STEM

<u>V. Positive infleunce / role model or mentor (not a parent or Haverford professor) on decision to major in STEM</u>