**Identity Development and Major Choice Among Underrepresented Students Interested in
STEM majors: A Longitudinal Qualitative Analysis**

Kate C. McLean¹

Isabella M. Koepf¹

Jennifer P. Lilgendahl²

¹ Western Washington University

² Haverford College

Corresponding Author Contact:

Kate C. McLean

Western Washington University

Department of Psychology, MS 9172

516 High Street

Bellingham, WA 98225

Phone: 360-650-3570

Fax: 360-650-7305

Email: Kate.McLean@wwu.edu

Acknowledgements. We thank the *National Science Foundation* (Award Number 1528433) and *Haverford College* for funding this project, as well as the Society for Personology for comments on an earlier version of this paper.

Abstract

The present study employed a narrative identity analysis to the examination of identity development in relation to major choice for college-going emerging adults. We focused on underrepresented minorities (URMs) who expressed an interest in Science Technology Engineering and Math (STEM) majors. In a qualitative, longitudinal, case-based study of URMs at two different campuses ($n = 26$), we followed their development through college over four years, engaging in a comprehensive analysis of their experiences, including individual differences in pathways of identity formation. Results revealed five trajectories of development that focused on the degree of certainty in major and career choice, and general psychological functioning and identity integration. Implications include the need to examine a diversity of experiences to understand the ‘whole person,’ which includes attending to motivations and psychological well-being, along with experiences in the classroom.

Keywords: narrative identity, major choice, underrepresented minorities, STEM, well-being, emerging adulthood

Identity Development and Major Choice Among Underrepresented Students Interested in STEM Majors: A Longitudinal Qualitative Analysis

It has now been well-established that specific ethnic minority groups in college are underrepresented in Science Technology Engineering and Math (STEM) majors (i.e., Black, Latinx, Native American), and that these underrepresented minorities (URMs) are vulnerable to attrition from academic pathways that lead to STEM majors and careers (Hawley, Cardoso, & McMahon, 2013; National Science Foundation, 2019; Seymour & Hewitt, 1997). In an effort to address these concerns, much research has been dedicated to identifying factors that explain STEM persistence vs. opting out among URMs (e.g., Azmitia, Syed, & Radmacher, 2013; Estrada, Hernandez, & Schultz, 2018; Hawley et al., 2013; Hurtado, Han, Sáenz, Espinosa, Cabrera, & Cerna, 2007; MacPhee, Farro, & Canetto, 2013; Robnett, Nelson, Zurbriggen, Crosby, & Chemers, 2018; Seymour and Hewitt, 1997). For example, two of the psychological factors that have been found to be critical to STEM major persistence among URMs are seeing oneself as a scientist (e.g., Hernandez, Schultz, Estrada, Woodcock, & Chance, 2013), and feeling a sense of belonging in one's major (e.g., Johnson, 2012). In other words, how URMs view themselves—*their sense of identity*—is critical to their academic decision-making and experience within their chosen major (Syed, Azmitia, & Cooper, 2011).

In the current project, we sought to build on these prior findings while also taking a different approach—one that puts the broader goal of *positive identity development in emerging adulthood* at the center of the analysis—and using an intensive longitudinal approach that allowed us to observe development over time. Rather than making the critical issue whether or not a student selects a STEM major, we focused on URMs who started out college potentially interested in majoring in STEM and followed them longitudinally, broadly examining their trajectories of identity development during college, with a primary focus on the role of major choice in this process.

As further elaborated below, we employed a novel narrative-based and qualitative method that was designed to gain a fuller and more subjective perspective on the overall developmental

experience of URM students who consider STEM. In particular, we had two assumptions underlying our approach. First, to understand the development of identity in terms of academics and career, attention needs to be given to the broader developmental context in which these experiences and choices are happening (e.g., Galliher, McLean, & Syed, 2017), including the general well-being and functioning of students. Second, to address these processes of identity development, an intensive longitudinal and narrative-based design is needed to fully observe the developmental dynamics underlying the various pathways that students take through college. Building on these assumptions, we were guided by one main research question: *What are the different pathways of identity development exhibited by URM students considering a STEM major, and how do their major choice and related experiences factor into this pathway and relate to their overall adjustment?*

We chose focus on different pathways or *trajectories* of development because of recent calls emphasizing that 1) identity content is not developmentally invariant, such that the configurations of identity-related experiences (e.g., major choice and ethnic identity) may change over time (Galliher et al., 2017), and 2) that understanding these shifting configurations over time helps us to understand the general well-being and functioning of students as they engage in this critical task of identity development. This approach to describing trajectories is relatively uncommon, as it is basically an approach centered on “types”. Defining a trajectory involves taking a large amount of data (the development of various aspects of self over time; see Syed & McLean, 2016), and subsuming it into one category to capture developmental dynamics over a relatively extended period. Type trajectories are more commonly examined using quantitative methods, given the ability to identify similar growth-curve trajectories on variables repeatedly measured over time (e.g., Herle, Micali, & Abdulkadir, 2020). In contrast, our approach was to identify types that emerge from a qualitative analysis that is attuned to a broad range of experiences, and does so with an uncommonly rich and extensive set of narratives for each student, ranging from the summer before college starts through the next four years. We propose that this this novel approach allows us to understand, in much

greater depth than is typical, who shows a positive progression of identity development in relation to academic experiences and major choice, who struggles more in this process, and what this contributes to our understanding of the quality of the college experience for URM students, both for those who opt into STEM and those who take a different academic path.

Identity Development: Contexts and Processes

Our primary theoretical framework draws from the literature on how identity development intersects with the college experience. For most, college attendance also takes place during emerging adulthood – a time when the developmental tasks of exploring identity possibilities and forming an integrated and coherent identity are prominent (e.g., Arnett, 2000; Erikson, 1968; Lilgendahl, 2015). The college context plays a potentially important role in identity development because of the opportunities for self-exploration across multiple experiences. Exposure to diverse opinions, new ideas and people, challenges to existing worldviews, and academic explorations all make college a rich context for developing conceptions of self and future plans (e.g., Arnett, 2006; Azmitia, Syed & Radmacher, 2008). Further, college students who make successful progress in forming an identity tend to have more positive well-being and self-esteem (e.g., Berzonsky, 2003; Marcia, 1967). However, this process is not necessarily an easy or smooth one. The process of figuring out who one is, where one fits, and who one wants to be is can bring considerable anxiety and uncertainty (e.g., Crocetti, Rubini, & Meeus, 2008), particularly in the context of navigating the transitions into and out of college and the academic and social ups and downs along the way.

One way to make sense of such salient experiences is to reflect on them via autobiographical reasoning (e.g., Pasupathi, Mansour, & Brubaker, 2007) – a process in which individuals consider the meaning of important past experiences to the current self. According to the narrative identity approach (McAdams & McLean, 2013), this meaning-making process is a critical component of healthy identity development. Focusing on how students engage in autobiographical reasoning about

salient experiences during college can reveal individual differences in trajectories of identity development (e.g., Lilgendahl & McLean, 2020; Syed, 2010).

Identity and Major Choice. Major choice is a significant, identity-related event that is likely to be a rich source of autobiographical reasoning for many (Perez, Cromley, & Kaplan, 2014). Exploring and coming to understand one's interests and strengths, as well as the practicalities of moving through college in a timely fashion with a viable job at the end, can invoke reflection and thought on who one is and who one would like to be (Luyckx, Klimstra, Schwartz, & Duriez, 2013; Vosylis, Erentaitė, & Crocetti, 2018). In particular, the certainty, or lack of, in what one will pursue during college can play a central role in self-definition and psychological functioning. Those who are able to develop clear ideas about their major choices may have a more positive psychological experience in part due to the reduced uncertainty, as well as the sense of purpose that having a major can bring, potentially leading to a more secure and integrated sense of one's self over time (Erikson, 1968). We reasoned that a longitudinal, narrative identity approach that highlighted patterns of autobiographical reasoning in response to accumulating college experiences over time would be a powerful way to examine individual differences in trajectories of identity development, particularly as they relate to major choice.

Identity, Major Choice, and URMs. Although considering the role of major choice in identity development is likely to be applicable to any college student pursuing any major, this approach may have especially critical value for URMs considering a STEM major, given their disproportionate vulnerability to STEM attrition relative to White and Asian students and, more generally, identity challenges in the college context (Syed et al., 2011). One recent study shed light on this issue by examining how college students reason about major choice in relation to their ethnic identity using a longitudinal and qualitative analysis similar to the approach we take in the current study. Specifically, Syed (2010; see also Cooper, Chavira, & Mena, 2005) found that movement towards integration of, or compatibility between, academic and ethnic identities was relatively

common, but more so for URM students than majority students. Further, this integration among URM students was found to be more supported by non-STEM majors than STEM majors. The authors concluded that finding a healthy identity for URM students might pose challenges in majors that do not facilitate exploration of ethnic identity. This demonstrates the importance of looking at all majors, not just STEM, and to a consideration of how different types of experiences may inform the identity development process, the focus of the present study. Indeed, the frequency and intensity of our narrative assessments provides greater depth on the full range of experiences reported by URM students considering STEM.

More broadly, students of color attending predominantly white institutions (which includes the current sample) may face a range of challenges both inside and outside of the classroom, such as microaggressions, low feelings of belonging, and chronic feelings of social identity threat (Easterbrook & Hadden, 2021; Mills, 2020). Within this broader social and academic reality, major choice and its relation to identity development may take on layers of complexity and distinct meaning for some students that an open-ended, exploratory approach is uniquely equipped to reveal.

Present Study

The current study utilizes data from the *Identity Pathways Project*, a narrative-intensive longitudinal study of college students in the United States. This dataset offers a uniquely contextualized and process-oriented approach to the study of identity development and major choice. This study is tailored to the developmental transitions and contexts significant in college students' lives - in this case academic experiences and major choice. We also include two different campuses – one with much stronger structural support because of its size, but that is also more elite, and one that is a mid-size public university, both of which are predominantly white institutions.

Our sample comprised URM students (we exclude White and Asian heritage students¹) who persisted in and desisted from STEM majors. However, as noted, we did not compare these groups, but

¹ Although Asian heritage individuals are an under-represented minority in the US (US Census Bureau, 2010) they are over-represented in STEM majors (NSF, 2019).

instead created groups using a bottom-up approach, based on their psychological experiences. We employed a qualitative analysis to examine cases of URMs who expressed interest in STEM during the summer before college started, and assessed them three times per year for four years, for a total of 12 assessments. At each assessment extensive narratives were solicited, designed to capture participants experiences in college, including specific questions about major choice.

Methods

Each of the samples were collected under IRB approval at the following institutions: Campus 1: Haverford College (proposal entitled, “The Identity Pathways Project -- A Longitudinal Study of Narrative Identity Processes, Contexts, and Outcomes During College”); Campus 2: Western Washington University 14-038: Identity Pathways Project.

Participants: Overall Study

Participants were drawn from the Identity Pathways Project (IPP), a longitudinal study of college student development at two institutions: a small, private, highly selective liberal arts college in the Northeastern United States (Campus 1) and a medium-sized, public, moderately selective state university in the Northwestern region of the United States (Campus 2).

The samples at each institution were recruited over the summers to complete Wave 1 prior to starting college in a staggered fashion across two cohorts (recruited between 2013 – 2015), with an aim of recruiting approximately 300 participants per campus. All members of the entering classes for Campus 1 were invited to participate, and 48% ($N = 159$) of the incoming class of 2013 (Cohort 1), and 45% ($N = 157$) of the incoming class of 2015 (Cohort 2) did so.

For Campus 2, there were approximately 3000 students in the entering classes for Cohort 1 and Cohort 2. Every student who went to the summer orientation event (90% attendance rate) received a flyer about the study. For Cohort 1, we randomly selected 400 students (gender balanced) from the entering class to receive an invitation to participate in the study via email. Once 150 people completed the survey, we stopped recruiting participants. A similar procedure was used for Cohort

2, except that we over-sampled underrepresented students interested in STEM fields. An email invitation was sent to 500 students, which was a combination of randomly selected students, and non-Asian ethnic minority students interested in STEM. This resulted in 173 participants for Cohort 2. Across the two campuses and cohorts, a total of 638 participants completed the Wave 1 survey in the summer prior to college ($n = 315$ for Campus 1 and $n = 323$ for Campus 2).

For the full Wave 1 sample, 35% ($n = 221$) identified as male and 63% ($n = 405$) identified as female (eight wrote in alternative responses for gender and five were missing). For race/ethnicity, participants were allowed to select all applicable response options and write in their own response if “other” was selected; 75% selected white, 6% selected Black/African-American, 10% selected Latino/a, 18% selected Asian, 2% selected Native American, and 1% selected “other”. Additionally, 13% selected more than one racial category. While this overall pattern was quite similar across campuses, there were significant differences in the proportions selecting white (Campus 1 = 69%, Campus 2 = 80%) and Black/African-American (Campus 1 = 9%, Campus 2 = 3%). This pattern is consistent with both institutional and regional demographic differences between the campuses.

Socioeconomic status (SES) was assessed with household income and parent education. The campuses differed on all indicators of SES. Household income was assessed with nine categories, with 1 = less than \$10,000 a year to 9 = over \$200,000 a year. The mode for both campuses was \$90,000-\$120,000 and the range for both campuses was 1-9; however, for Campus 1, 43% fell below \$90,000 and 36% fell above \$120,000, whereas for Campus 2, 60% fell below \$90,000 and 21% fell above \$120,000. The most extreme disparity was in the highest category of over \$200,000, with 20% for Campus 1 and 5% for Campus 2. For Campus 1, 45% of mothers had a master’s degree or higher, 33% had a 4-year college degree, and 21% had some college or less. Similarly, 52% of fathers had a master’s degree or higher, 23% had a 4-year college degree, and 22% had some college or less. In contrast, for Campus 2, 22% of mothers had a master’s degree or higher, 26% had a 4-

year college degree, and a 53% had some college or less. Similarly, 22% of fathers had a master's degree or higher, 28% had a 4-year college degree, and 50% had some college or less.

Sub-Sample for STEM Analyses

Forty-one percent ($n = 128$ students) of the Campus 1 sample reported an interest in a STEM major at Wave 1. Thirteen percent ($n = 17$) of those participants were URM (non-Asian ethnic minority students). Twenty-three percent ($n = 74$ students) of the Campus 2 sample reported an interest in a possible STEM major at Wave 1. Eighteen percent of ($n = 13$) those participants were URM. Four of these qualifying cases from both campuses were dropped because they missed more than half of the assessments. Thus, the final sample includes 26 participants ($n = 17$ female, $n = 8$ male, $n = 1$ unknown; $n = 13$ from Campus 1; $n = 13$ from Campus 2; see Table 1 for demographics).

Defining STEM Majors

A STEM major was operationally defined in terms of actual majors that could be declared on each campus. Majors that were defined as STEM at Campus 1 were: Biology, Chemistry, Computer Science, Physics/Astronomy, Geology, and Math. Campus 2 offers a much wider array of majors. Majors that were classified as STEM at Campus 2 were those listed for Campus 1 as well as Engineering, Behavioral Neuroscience, and Environmental Science.

Procedure

The general design of IPP is a multi-wave online survey study in which participants are surveyed in the summer before college begins (Wave 1), two more times during freshman year, Winter (Wave 2) and Spring (Wave 3), three times a year for each year of college after that, Fall, Winter, and Spring (Waves 4-12) and a one-year post-graduation follow-up (Wave 13). In other words, for a traditional four-year college trajectory Waves 1-3 is the first year of college, Waves 4-6 are sophomore year, Waves 7-9 are junior year, and Waves 10-12 are senior year. The current analyses involve data from Waves 1-12. There are multiple quantitative measures collected at each

wave (<https://osf.io/cdgka/>), but the present analyses were focused on the open-ended responses and narratives collected at each wave, described below.

Materials

This unique and rich dataset provides an enormous amount of qualitative material. Given our focus on major choice and career identity, we first describe the narrative prompts that most closely targeted those issues. We then describe our additional prompts that allow us to evaluate a fuller, more complete set of experiences for each of our participants, taking advantage of the maximum amount of narrative material for each person. All prompts are available on OSF (<https://osf.io/cdgka/>).

Primary Narratives

Wave 1 included a self-defining memory (Blagov & Singer, 2004), what major(s) and career the participant was considering, past experiences influencing major/career plans, expectations for romance in college, and overall anticipation of college.

Beginning at Wave 4 we began asking if a major was declared, and if so, what experiences and people had been influential in determining the major choice, and how it was related to career plans. We also asked about whether and how identity characteristics, such as ethnicity, gender, SES, religious or political beliefs, or disability had any influence on their decision or thinking about major choice. If students had not yet declared, we asked what they were considering and why, and continued to ask these questions in subsequent waves until they declared. Once a major was declared, we asked about whether they had changed their major in subsequent waves (and if so, why). At Wave 12 we also asked about participants' plans for the next few years, what we had missed in our questions over the course of the study, and an evaluation of their experience being a part of the study. Waves 3, 6, 9, and 12 included academic high and low point memories that had occurred in the past year – events that were extremely positive or negative, and meaningful to the

participant. Academic memories were followed by questions about how the event had impacted major/career plans, if at all.

Additional Narratives

Waves 2, 5, 8, and 11 included questions about the transition to college broadly, and the impact of the transition on academics, family, and peer/social life, as well as a specific memory about the transition. Waves 3, 6, 9, and 12 included romantic high and low point memories that had occurred in the past year. Waves 4, 7, and 10 included a future self-defining memory, defined as an event or experience over the past year that was significant in defining one's ideal future self.

Analytic Procedure

Our framework for analyzing these data comes from a thematic analysis approach, involving reading and re-reading the word document containing all of the waves of narratives responses, organized chronologically from Wave 1 to Wave 12 for each participant (Creswell, Hanson, Clark, & Morales, 2007; see also Wertz, Charmaz, McMullen, Josselson, Anderson, & McSpadden, 2011). Importantly, each theme characterized a trajectory across waves, capturing processes of development in one category. For each 'read' of the participants' narratives, the unit of analysis was the entire document (all narrative data). This approach maximized flexibility and sample size by not attaching our analysis to responses to any one specific question or wave; each participant had adequate responses across the maximum of 12 waves to analyze their general identity trajectory through college. We had a different guiding question(s) for each read, described below. We chose this inductive framework because of our aim of guiding new lines of inquiry.

The analytic team consisted of the first and second author, a professor of psychology, and an undergraduate in psychology who had opted out of a STEM major, both white females. The third author, also a white female, had completed a preliminary analysis of the STEM major trajectory as part of a senior thesis project with a team of undergraduates. This latter analysis only examined Campus 1, and was not shared with the first or second author until after the present analyses were complete. In

terms of our reflexivity, the coding team (first and second author) discussed our positions as white women in different positions of power (professor, student), and the experience one of us had as a prior STEM major, and that neither of us was an under-represented ethnic minority, which may limit what we observed (see Levitt, Bamberg, Creswell, Frost, Josselson, & Suárez-Orozco, 2018). We immersed ourselves in the literature on URM in STEM, including qualitative papers that privilege the voices of participants and papers by scholars of color (e.g., Nasir & Shah, 2011; Shillingford, Oh, & Finnell, 2017; Syed et al., 2011; Winston, Wall Rice, Bradshaw, Lloyd, Harris, Burford, ... & Burrell, 2004).

Our broadest guiding question was to understand the trajectory of the individual's identity development as it relates to their major choice and college experiences more generally.

Phase One: Relevant Themes. Our first read of the narratives was broad, and was designed to understand the data with which we were working. This was the first time that the coding team had read the full set of narrative data for any participants in this project. We took notes on themes that stood out to us, resulting in observations about the balance between academics and social life, the role of ethnic identity and racial consciousness in the college experience, familial expectations and needs, motivations for major/career choice, stability and changes in patterns of certainty about major/career choice, and the role of academic experiences in major/career choice. We began with Campus 1, and then turned to Campus 2, noting similarities and differences in the campuses – though we do not report those analyses here.

Phase Two: Profile Development. For the second read, our aim was to create profiles, or summaries, of each case in terms of familial influences, academic and romantic experiences, ethnic identity development, the role of SES, and feelings about the institution – all in relation to the choice of major/career. Based on our reading during Phase One, we also decided to ask six questions of each case: 1) How does the college transition story change over time? 2) What do the self-defining memories tell us about the major choice? 3) What themes are stable? 4) What themes emerge? 5) What themes change (i.e., increase or decrease in prevalence/importance)? 6) How much is the

person engaging in autobiographical reasoning? We also took notes on two questions for each case, which became the primary data to establish trajectories in Phase 3: the participant's broad evaluation of the college years, and the trajectory of their development in relation to STEM and major choice. Our analyses of these two questions primarily addressed the participants' emotional evaluations of their experiences, and their certainty about their major choice and career development.

Phase Three: Establishing Trajectory Categories. We then grouped cases that followed a similar trajectory, based on the two questions about their overall evaluations and certainty, described above. For this third read we reviewed the cases assigned to each trajectory category to determine that they did indeed share commonalities, refining the label and definition of each category, and moving cases or combining categories as appropriate. After this process, we re-read the participants in each category to see whether each category was coherent. This process resulted in five trajectory categories.

We first conducted this coding process on Cohort 1 (while Cohort 2 was finishing its 4th year). Once Cohort 2 was complete, we conducted the same analysis with the second cohort, akin to a qualitative replication. Although we were open to new categories emerging, all cases fit into our existing categories. Thus, we report the analysis of both cohorts combined below.

Results

In the following we describe our five Trajectory Categories. Please see Table 1 for a complete listing of the relevant demographic information for each case.

Trajectory Category 1: Stable Uncertain

This category comprised participants who both desisted from and persisted in STEM, and who shared four primary similarities. First, there was a prevalent and consistent uncertainty about academic ability. For example, one woman who failed a course during her third year reported:

I felt like an idiot. I was filled with anger and deep sadness that left me listless. This just made me feel like I'm not smart, good, dedicated enough to make it through the work ahead of me. Like maybe I'm not enough to be a doctor after all. (Campus 2, Wave 9; ID 1)

In talking about the transition to college, another reported: “I feel much less capable in my academic skills. In short, this school makes me feel a bit stupid.” (Campus, 1, Wave 2; ID 2). As will be seen in later categories, such feelings of inferiority were not limited to this group of cases. Critically, statements such as these showcase the type of negative autobiographical reasoning that can be so damaging to developing a positive identity for anyone (e.g., Lilgendahl & McLean, 2020). And they may have especially damaging implications for URM students attending predominantly white institutions, who may experience feelings of academic inferiority within the broader context negative stereotypes and social identity threat (Easterbrook & Hadden, 2021).

Second, there was a theme of uncertainty about the future, reflected in limited autobiographical reasoning about the meaning of the events participants had experienced. For example, one participant reported that she chose her major because, “...a psychology major can be manipulated to fit many different careers, so I don't have to make any career decisions yet.” (Campus 1, Wave 5; ID 2). At Wave 6 the same participant reported: “I have no thoughts about my career. I have no idea what to do with my life.” Another participant wrote: “I have no clue what I want to do with my life and that makes it very hard” (Wave 1, Campus 2; ID 2). At Wave 6, she continued the theme “I now don't know exactly what I want to do with my life so I am having to slow down and take a step back to figure it out.”

Third, they were not highly exploratory about their major and career choices. For example, one young woman at Campus 1 reported choosing her major because people kept asking her about it: “As people asked what my major would be I found myself saying psych without truly even thinking about it” (Wave 4; ID 2). At Wave 6 she wrote, “I took intro psych first semester and I found it new and intriguing so I went with it.”

Finally, they reported little intrinsic motivation, or motivation guided by internal reward that is enjoyable and need-satisfying (e.g., Patall, Cooper, & Robinson, 2008), for their studies. For

example, one participant reported at Wave 1 (ID 3): “When I see myself at [Campus 2] currently I see myself very busy working and studying trying to keep my head up.” A few years later at Wave 8, the lack of personally meaningful goals for this person is even more pronounced and negative: “I don’t really have a reason to come to college it was just what you are ‘supposed’ to do so I’m doing it.” Another participant wrote at the end of their junior year, “Right now I’m wondering if college is really for me and if I have just wasted my time working at something that doesn’t fit and/or in meaningless to me” (Wave 9, Campus 1; ID 4). This participant also reported earlier external pressure from her mother that superseded her own desires:

“My mother wants me to become a doctor. Early on she warned me not to take psych course because they were not what ‘we’ were working towards. ...my mother has had the biggest influence on my uncertainty because I want to respect and honor her wishes, but I don’t know if I am as smart as she thinks I am...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” (Wave 5, Campus 1)

At Wave 12 the same participant writes, “I’m a bit worried that I won’t be cut out for the rigors of further pursuit education or a steady job,” reflecting the relatively chronic uncertainty in this group.

Though there is similarity between these participants, we do note that one important difference was the role of ethnic identity. Of these cases, only one discusses her ethnic identity. Indeed, for the participant above who discussed her mother’s pressure, her home culture plays a powerful role in her decision to pursue a STEM major, but she views it as restricting an exploration of her own academic interests, and this aspect of her self remains relatively unintegrated into her overall identity (in particular contrast to the cases in Trajectory Category 5).

In short, regardless of persistence in STEM, these cases all share a pervasive and consistent relative struggle to find momentum, lack of direction and positive autobiographical reasoning, and self-doubt, themes that draw our attention to the role of general well-being and psychological functioning in considering pathways of development in major choice. Further, this persistent

uncertainty seems rooted a variety of potential causal factors worth noting, including intense feelings of academic inferiority and pressure from family.

Trajectory Category 2: Stable Certain

These two cases both persisted in STEM and remained certain about their choices throughout the assessments. The primary shared characteristics are high confidence and satisfaction in their choices reflected in positive processes of autobiographical reasoning focused on stability, which is quite distinct from many of the other participants, regardless of category.

For example, at Wave 1 one participant at Campus 1 reported (ID 5): “My love for Physics has developed over the past 2 years into something solid. I have had many people and events influence me.” Even after struggling in Physics and switching to Mathematics, his confidence is preserved at Wave 3: “I decided I would make a better math major than science major. This realization has not changed my desire to research though, only the fields in which I'd like to do research.” At Wave 6 he reports, “I am pretty wholeheartedly committed to applied mathematics graduate school, but I want to work in industry/government for a few years in order to understand applied mathematics from the inside outwards.” At Wave 12 he has been accepted to a prestigious graduate program in Mathematics.

Similarly, the other case (Campus 2; ID 6) discussed his long-term interest in coding at Wave 1: “I wrote my first batch file and permanently broke 6 computers at my high-school. It was then I realized how much I loved writing code and testing it on machines.” At Wave 5 he elaborated on the theme:

I love working with technology and solving real world problems that improve the lives of others... I primarily came up with my decision to major in computer science in High School. If there was any extent to how people influenced my decision it was in how they supported my choices.”

And at Wave 9, after declaring a computer science major, he wrote: “I know that I’m on the right path, I’ve always known but it’s nice to feel what it feels like to be on the right path.” Finally, at

Wave 10:

I found myself really taking stride and working as an independent professional this summer. I spent a lot of time programming and learning new things outside of the classroom. I feel like I have taken my own learning into my hands and it has brought me a lot of security in my skills.”

Thus, throughout the assessments both are positive and certain about their trajectories, even when they experience what might feel like setbacks to others (e.g., academic struggle). There was also little mention of aspects of their identity characteristics that might be related to their major choices. Indeed, when asked directly about the role that their identity characteristics, such as ethnicity, played in their major choices, they both responded that there had been no influence. Both cases were also happy and thriving in their social lives.

Overall, we note that Trajectory Categories 1 and 2 both share a kind of stability – meaning that their overall outlook remains fairly stable, but that outlook is dramatically different between the two groups that we differentiated by their certainty – one filled with despair, hopelessness, and external motivation, and the other with confidence, satisfaction, and passion for their work.

Trajectory Category 3: Developing Certainty

This category includes a mix of STEM and non-STEM majors. What these cases share is a relative uncertainty at the beginning of their studies, and an increase in both autobiographical reasoning and certainty. Like Trajectory Category 1, they all seem to share feelings of inferiority in STEM classes, reporting that they do not have the intelligence or skills for such majors. But they experience a growing emotional competence, which seems to lead to an emphasis on finding what they love or are good at; that is, major choice becomes about finding a personal passion. Coupled with this development is an increasing valuing of independence, sometimes manifesting as pushing

back on others' expectations that they should pursue STEM. Finally, the experience of emotional competence and well-being seems to precede the ability to explore.

For example, at Wave 1 one participant at Campus 1 (ID 7) reports wanting to major in Applied Physics, and potentially double major in Anthropology, but says his ideas about career are “not set,” reflecting the initial uncertainty of this group. At Wave 3 he reports a good experience in an Anthropology class and a poor experience in Physics, which begins to define his trajectory, as well as his beginning engagement with the meaning of these past events for his developing identity.

My experience in Physics this past year was a low point for me. I had never taken Physics before but I was interested in taking the intro course and possibly majoring in the field. However, it was more than the difficulty of the course that turned me away, it was the overall sense that they only wanted people who were already comfortable with Physics. It was hard to say I didn't want to major in it anymore because it felt like I was backing down because it was hard. But in the end, I realized I had done my best and I wasn't into it... While I still like science and math, I have decided to follow a social science direction. I found more joy in my anthropology course than I ever did in Physics.

At Wave 5 he emphasizes the importance of his independence, which seems to be a part of his explorations of major choices. “Living away from home made it so that I could be as autonomous as I was. This has led me to create many opportunities for myself because I am comfortable on my own.” He reports that he is now interested in majoring in History, and says it is “...hard to explain. I've always loved history but I didn't consider it until last semester. It comes naturally and I find it interesting.” At Wave 6 he is thriving, saying of his major choice:

I feel great about my major. I've been able to interact with people in the field and find opportunities that interest me. It gives me the confidence I need to pursue my interests without worrying about their practicality.

At Wave 9 he reports similar enthusiasm:

I think this semester really cemented how I view myself academically. Despite feeling like my best wasn't going to be enough, I realized that it was in fact very good. I feel more confident in my work now.

Like this case, on which we provided more elaboration, other cases reported a trajectory of increasing internal motivation and satisfaction in their studies:

One of the highest points in my academic career was when I gathered the courage to declare a major in fine arts with a concentration in photography. It felt good to finally realize what it is that I wanted to do, and not what I expected of myself, or wanted myself to want. I only have one college experience, and I do not want to spend it pursuing an academic endeavor in a field that I do not fully enjoy. The decision was primarily personal and really only involved myself, and a little support from my parents. I guess the actual point would be when I physically handed in my paper to the registrar, but it was a gradual feeling of greater confidence that resonates still. (Wave 6, Campus 1; ID 8)

It was definitely a growth experience to engage in a debate with peers, in the context of a course I genuinely enjoy. To me, it felt like this experience was a small peek into what it could be like to work with teams of scientists potentially down the line. Also, I truly just enjoyed working with a team in an academically stimulating environment. (Wave 3, Campus 2; ID 9)

This positive autobiographical reasoning showcasing the developing of certainty and commitment in identity is similar to other narrative excerpts that focus on the development of autonomy and independence, and the value on it:

My relationship with my parents does not feel too different yet, but I definitely feel more independent from them. Before I left, it felt like they were trying to control my decisions too much and that put a strain on our relationship. Now, since I'm more independent, our relationship is not as strained. (Wave 2, Campus 2; ID 9)

I realized that I was not passionate about pharmacy at all, and that I was only taking that path because it was what was expected of me and was convenient. I turned towards geology because I realized that through all of my hobbies/interests, geology and how the earth works is the one that has stuck with me since I was a child. I love being outside and understanding the earth, and I realized that if I wanted to get deeper into it -- now was the time to take that life path. (Wave 4, Campus 2; ID 10)

Over this last year I decided that I am going to major in psychology. It has been something that I have been interested in for a while now but people had always told me that it was a nonsense idea and field. That it wouldn't take you anywhere. I never wanted to believe this because I just find it so interesting and important, so I finally decided that I'm going to do what I want to do and not think about what anyone else has to say. A lot of the naysayers were from my own family so it made it really hard to try and put their thoughts to the side to make myself happy. (Wave 10, Campus 2; ID11)

Thus, across these excerpts we see the development of joy and passion, coupled with a growing sense of independence and confidence, reflected in the autobiographical reasoning about important and salient experiences. Additionally, in each of these cases, there is a negative force that is overcome by these positive experiences – family pressure, an unwelcome feeling in a STEM course, one's own

biases against what is a valuable major, etc. – revealing an impressive amount of agency and resilience in these URM students as they find their own, self-defining paths.

The final commonality that these cases share is that none reports exploring their ethnic identity. For example, in response to the question about influences of identity characteristics on his major choice, one participant writes, “As far as I know my choice has been entirely my own. If those aspects have come into play, they have been passive” (Campus 1, Wave 5; ID 9).

Trajectory Category 4: Developing Possibilities

This category was comprised primarily of students who did not persist in STEM. Beyond that, there were two main commonalities in these cases. The first is that they began college with certainty about their STEM major interests, but they increasingly engaged in autobiographical reasoning as they explored other options after negative experiences in their STEM courses. However, as seen in the examples below, this exploration was painful. Indeed, like many of the others, these cases expressed feelings of inferiority to other students in the initial assessments, and their self-confidence seemed to only slowly increase. They were certain in their switch to a different major, but were only slowly starting to develop identity certainty with respect to their overall sense direction in life and career path. The second commonality is little reference to or integration of ethnic identity into their major choice.

One participant at Campus 1 exemplifies this trajectory in several ways. In terms of certainty at the beginning, at Wave 1 he reports that he wants to be a Cardiologist, majoring in Biology or Chemistry, because (ID 12):

Witnessing how many people die from cardiac arrests and the pain it causes is impacting to me. I see the heart as the centerpiece of life but also of emotion. Seeing how its death has a great impact on mankind motivates me to want to treat the heart and help repair it.

This enthusiasm is carried throughout the assessments – at Wave 5 he reports:

I see biology as a gateway not only trying to send the human body, but also has a manner to be able to relate with people in an empathetic manner and a physical one as well.

However, when his struggles in STEM classes force him elsewhere, detailed in an academic low point at Wave 6, he begins to consider Anthropology, which opens up new possibilities for the future and for self-worth. At Wave 9 he reports:

An academic high point of me this year was switching my major to anthropology. It was an enlightening experience seeing possibilities outside of biology. Seeing myself succeed in that made me feel proud.

And at Wave 10:

I believe taking History and Theory of Anthropology alongside Bioethics definitely helped me focus and consider aspects of medicine that I would not have before like immunology and epidemiology. Learning from these courses was beneficial as I gained a perspective in how outcasts and minorities are treated and how I can help.

At Wave 12 he reports:

Ideally, by now, I would have had a job within the public health field as my senior thesis focused on HIV and AIDS; however, thanks to our current president, that is not possible. I am still looking for employment then afterwards I plan on applying to graduate school in California.

Another case from Campus 1 provides an example of the intensity of feelings of inferiority from the beginning, and how it is inextricably tied up with one's status as a URM at a predominantly white institution (ID 13). In anticipation of college at Wave 1 she writes:

I am worried I am not smart enough to compete with my peers. I'm worried I might get frustrated. I'm scared of getting bad grades and losing my scholarship. I'm worried I won't click with anyone and won't have friends and of racism since I am in the minority at [Campus 1] being Hispanic.

At Wave 3 she discussed a challenging Chemistry class:

I was wondering why all my efforts were not producing the results I wanted. I started to question, my intelligence, and why I'm even in college in the first place. I felt useless. If I am not intelligent enough to be a science major then there is no reason to be in college.

However, we also see glimmers of more expansive autobiographical reasoning and exploration across the assessments. At Wave 6 she discusses her dislike of Chemistry and realizes she may not be tied to it forever: "I don't think I'll do chem for the rest of my life. I want to travel to south Korea or Japan. I am interested in East Asia and hope to work there for some time." At Wave 7, in talking

about a positive romantic experience she says, “So I have been thinking more about myself lately. Taking care of my appearance, and loving myself. Tho I still have confidence issues.” At Wave 12 she says she wants to do clinical work with patients, beginning to find a path forward.

Other cases also reported the themes seen in these two examples, including feelings of inferiority:

It was difficult being surrounded by colleagues that are similar or greater in mental capacity. They have pushed me to succeed and challenge myself to do better. (Wave 8, Campus 1; ID 14)

“I felt like a piece of trash unworthy of being here, and felt constantly reminded of a fictitious yet tormenting feeling of inferiority to all of my classmates that I admired so much. I admired everyone, but I also felt that every person I walked by was probably more qualified than I was. (Wave 8, Campus 1; ID 15)

And they also reported the exuberance of finding joy in their studies:

I just didn't feel that same passion for Biology for the classes that I'm taking now. I'm into the Health classes and how to improve everyone as whole and not the individual. I've always loved Sociology.” (Wave 6, Campus 2; ID 16). And at Wave 7: “I feel like I'm hitting that point in time where I'm heading in the right direction, as long as things go according to my plan.

The classes I took and my passion for art is what made me change. I absolutely hated the math and science classes I had to take and knew that if this would be my everyday life I would be miserable. (Wave 7, Campus 2; ID 17)

Thus, these cases share the disruption of plans being readjusted or thwarted, the pain of low self-confidence, and the growth as they find themselves, their own interests, and their passion. But their paths are still quite open at the end of our assessments.

Trajectory Category 5: Increasing Certainty and Integration

The participants in this category showcase the various, complex ways in which major/career identities develop in conjunction with varied life experiences and in connection with ethnic identity. These cases share three primary themes. First, they have a relative certainty in their initial interests in STEM (like Trajectory Categories 2 and 4). Second, they show an increasing orientation towards discovering their own interests, reflected in their autobiographical reasoning processes (like

Trajectory Category 3). Finally, and unique to this group, they show an increasing orientation towards issues of social justice. There are a variety of life events, inside and outside the classroom, which shift or confirm the initial interests of these cases, but what they share is a trajectory of increasing exploration that leads to increasing certainty, confidence, and excitement about their major choices and future lives.

In terms of initial certainty, one participant at Campus 2 wants to be a science major because (ID 18):

My family has always wanted someone to be a doctor and I like helping people. Also I really enjoy science and that is why I am leaning more towards being a Biology Major.

With this certainty, she also shows an openness towards discovery, with a mindset open towards exploration and growth, which is facilitated by experiences in the classroom. At Wave 3 she reports:

I am concerned about not choosing the right major but this is a time of learning and growth so I think it's ok to change my mind...it [a meeting with a professor] helped me to see what I was doing in a different perspective and for the first time I was really open to study other areas that had captured my attention and not just the major that I had chosen before starting at [Campus 2].

But the switch is not quick. At Wave 4, she still reports the family pressure for a practical major:

...I am a first generation female of color so I know and I have feeling that there is a big push for me to go into the sciences which really influenced me to be a Biology major...

Half-way through the assessments she starts to focus in on her goals, finding a passion and happiness in her art classes. At the same time, there is a racist incident on campus that creates chaos and fear amongst students of color, shaking her deeply. She wrote about it at Wave 6 as her academic low point, and at Wave 7 as part of her future self-defining memory:

I think that event really made me want to be more informed and learn more because not everyone gets that chance and I really reflected on what kind of person I wanted to be. I decided that I really did want to be involved in social justice and human rights and it really strengthen the idea that I want to bring back what I learn into my community.

This desire is realized at Wave 11 when she reports her desire to be an immigration lawyer to give back to her community.

Similarly, another participant at Campus 2 is also initially certain about being a STEM major, but she struggles in those courses, and begins to see other classes as potentially more invigorating and confidence-building. At Wave 3, she reports (ID 19):

In fall quarter, I was in [political science course]. I was the only freshman and part of the final was a mock parliamentary session. I'd been battling social anxiety and had no friends in the class so by the time it rolled around I was so stressed about it the professor said that I wouldn't need to speak if my written portion was done well enough. I spend two all nighters and four days on the paper which let me do more than well enough to opt out of speaking. I somehow managed to speak during the session anyway... This actually moved me towards thinking of picking up a political science major.

However, she struggles with a traumatic accident that caused her to take time off, and at Wave 6 she cannot think of an academic high point, reporting "I've been having a hard time adjusting back to classes and general life patterns that were easily just a part of life beforehand." But at Wave 7, her perspective starts to shift:

[I] feel like the goals that society has set for people only has one version of success and the pressure to achieve that has really turned me off to following those rules. Future me should obviously be educated and successful but if push comes to shove I just want to be happy.

At Wave 9, another life experience intervenes – learning she had been the victim of a crime in childhood. This event, changes her life course dramatically:

This left me unable to properly focus on classes but it did give me direction for my academic courses. This has set me down an academic path for law school and pre-law major that lets me focus my interest in legal proceedings with my personal experiences and current-at-the-time political science major... This experience redefined and cemented my choice of major, taking it from a possible choice to my decided path because it became apparent how the subject matter could affect lives and I realized how passionate I was about law.

Thus, both of these cases experience a period challenging exploration, similar to Trajectory Category 4, but they experience a greater integration of the parts of themselves by the end of the study, and those found selves are strongly generative in nature.

Discussion

The extant literature on STEM points to a variety of constructs important to desisting

from and persisting in STEM, most often grounded in an analysis of social categories, such as ethnicity/race, or in relation to specific academic experiences (e.g., availability of mentorship, representations of diversity in the classroom, microaggressions). The questions we posed to our participants allowed for a much broader analysis of how they navigate their college experiences, allowing relatively unique insights into this process of major choice and how processes of identity development relate to major choice. We offer these interpretations as complementary to the vast literature on STEM, and we hope that this attention to the ‘whole person,’ produces new lines of research integrating the traditional STEM literature and the narrative identity approach that we took. Below, we discuss the primary new themes that emerged from this analysis. We also address ethnic identity and the developmental dynamics of this phenomenon, as well as questions for future studies.

The Role of Motivations for Major Choice

In examining these groupings, the theme most prominent in the stories of our participants appeared to be focused on the difference between intrinsic and extrinsic motivations – choosing a major and developing a career path that fulfills the individual versus something more practical, or what was perceived as externally motivated (e.g., meeting parental expectations). The excerpts often reveal the push and pull of thinking one is *supposed* to do science to serve a practical purpose, in contrast to actually loving science. This push and pull might be especially challenging for students of color at a predominantly white, liberal arts institution. The cultural context of a liberal arts institution that emphasizes intrinsic motivation and passion for one’s work may create real tensions for those whose family goals and ideologies do not fit the cultural context of the college campus. We also note that the issues of motivation were deeply intertwined with issues of competence. Those who felt incompetent in STEM often looked to majors in which they could feel competent (see Syed, 2010), and perhaps thus more intrinsically motivated.

This focus on intrinsic motivation, as well as the emphasis our participants put on their needs for autonomy and competence, is consistent with other theories that have need fulfillment at the heart

of identity development, such as self-determination theory (e.g., La Guardia, 2009; Ryan & Deci, 2000). Attending not only to internal processes, however, La Guardia (2009) points to the importance of educational structures that can impinge or enhance opportunities for developing intrinsic motivation. Thus, these data suggest that helping URM students to find this intrinsic motivation, and understanding the experiences that pose obstacles to doing so, may be a critical next step, particularly if value is placed on positive identity development and overall well-being of students in relation to their major choice and academic trajectories. Indeed, research that combines explicit assessments of classroom experiences and structural analyses with this kind of whole-person perspective may be particularly fruitful.

Role of Psychological Functioning

Ultimately, we want to see students experiencing equity in access to and support in their academic pursuits, and to conclude college with optimal psychological functioning rooted in an academic/career identity that gives them confidence and direction. Despite these twin goals, they are often not integrated in the literature in persistence and desistance from STEM. We were struck by the important role that general psychological functioning appeared to play in these identity trajectory groupings, reinforcing the close relationship between identity development and adjustment in college (Lilgendahl & McLean, 2020). In particular, Trajectory Categories 1, 2, and 3 showcased the ways in which psychological functioning can play a role in relation to certainty and exploration.

Trajectory categories 1 and 2 are a primary contrast, with low certainty and low psychological functioning for Category 1 and the opposite for Category 2. For those in Category 3 it appeared that psychological functioning improved prior to the development of exploration and certainty. In contrast, Category 4 revealed some painful examples of poor functioning that comes with the difficulty of starting out college with certainty that unravels and must be rebuilt over time. Finally, Category 5 showcased relatively high functioning, and was also the category with the most emphasis on integrating ethnic identity into major choice. In short, attending to the general functioning of

students may be critical for understanding the process of major choice and its relation to identity perhaps especially among underrepresented students who are marginalized on campus.

Although the role of identity development in psychological functioning is certainly applicable to all students, it is important to recognize the unique significance of this relationship for URMs considering STEM at predominantly white institutions. For example, one of the most notable characteristics of low psychological functioning in our sample was feelings of inferiority, which take on added weight for URMs with the potential burden of confirming negative stereotypes about one's group and perpetuating feelings of not belonging in college – forms of chronic social identity threat that are associated with a host of negative outcomes (Easterbrook & Haden, 2021). We saw some students struggle with these feelings of inferiority throughout college, which ultimately seemed to dampen their identity exploration and engagement with academics. In contrast, others were able to find pathways to greater identity clarity after feelings of inferiority, often through their own resilient efforts to find success or passion in new disciplines. However, it is important to note here that by attending to the psychological functioning of the students, we do not want to suggest that the burden of positive identity development be placed solely on their shoulders. The danger here is that such an analysis could mask the very real structural and systemic impediments to positive functioning for URMs (Easterbrook & Haden, 2021). Take for example, the student in Category 3 who starts out interested in Physics but struggles and ends up finding his way to a positive experience in a history major. While his case ultimately shows a positive trajectory, he also subtly notes that he felt unwelcome in Physics because the professors wanted students who were “already comfortable”. This one quote suggests something deeper and institutional that cannot be overlooked and should be considered in the context of feelings of inferiority in STEM courses. Indeed, the institutional norms and practices and limited opportunity for interactions with students and faculty of color may induce feelings of alienation, mistrust, and fear for one's safety (e.g., Love, 2009; Woldoff, Wiggins, & Washington, 2011). In other words, the practices and behaviors of white students and faculty, as

well as the structural norms and policies, may be significant causal factors in the psychological well-being of our participants. Student narratives offer entry points into discussing these issues, as they may reveal systematic problems that may be the root causes of poor psychological functioning and operate to shut down possible identity pathways for URM students.

Role of Ethnic Identity

Although some participants and categories (Trajectory Category 5) were in part defined by the role that their ethnic identity played in major choices, there was also a notable lack of exploration the role of ethnic identity, or perhaps more important, the integration of ethnic identity into other aspects of self, including major choice. This is noteworthy because scholars have argued that it is especially important for individuals to explore and understand ethnic identity in the context of under-representation (Tajfel & Turner, 2004), and in the context of major choice in particular (Syed, 2010). Syed (2010) found that the group with the least attention to ethnic identity was comprised primarily of White participants, but we find this is relevant to a sample of URM students here.

We found the limited attention to ethnic identity particularly notable for those who desisted, because prior research has found that one reason students opt out of STEM majors is because there are few to no opportunities to explore their ethnic identities in STEM disciplines, and students seek to find a major compatible with their ethnic identity (e.g., Azmitia et al., 2008; Syed, 2010). Indeed, engagement in coursework is a reliable predictor of retention, and one mechanism of engagement is to develop an identity that is coherent with one's major choice, as well as the expectations of others (Syed, 2010; Montgomery, Miville, Winterowd, Jeffries, & Baysden, 2000; Estrada, Woodcock, Hernandez, & Schultz, 2011). Interestingly, we had students who desisted from STEM majors, but still did not discuss the role their ethnic identity played in their interests (Trajectory Category 3). This category included almost all mixed students, who identified in part as White, so it is possible that they identified more with the majority culture. Alternatively, this may represent the phenomenon some scholars have proposed, from a post-modern perspective, which is that that even

when ethnic identity is salient, it need not be expressed in all contexts, such as academics, which some have called the “thrill” of a lack of integration (Schachter, 2004). And these participants seemed well-adjusted, finding their passions and thriving in college, similar to Syed’s group of compartmentalized students who found a way to separate ethnic and academic identities in a way that did not cause distress or tension.

We also note that participants may not have wanted to discuss these issues in this research context. Ethnic identity may also be processed, or discussed, differently in the context of a predominantly white institution (i.e., see comparison studies at HBUs, such as Mack, Rankins, & Winston, 2011). And, of course, our prompts may not have been effective eliciting these issues.

Although not a part of the present analysis, our participants also made clear, implicitly and explicitly, that the psychological meaning of membership to multiple social identities, not only race or ethnicity, combines to create qualitatively distinct experiences, which impacts one’s position of power and privilege (e.g., Collins, 1990; Ghavami, Katsiaficas, & Rogers, 2016). Possibly the most common intersection that we saw was being a first generation student of color, which was often raised in relation to concerns with financial struggles and security for self and family.

Developmental Dynamics

We first note that much of the movement we saw was slow, rather than sparked by one moment (see Josselson, 2009; Syed, 2010), showcasing the necessity of intensive longitudinal assessments. Indeed, many of the conceptualizations of development focus on moments of realizations, or “turning points” that shift developmental trajectories suddenly. Although individuals may represent their experiences as moments of crystallization or sudden awakenings, when we take the time to examine development slowly over time, a different pattern is revealed. This may have implication for the ways in which we conceptualize identity development to students in the college context – when crises or challenging times emerge, normalizing the slow pace may be more helpful.

However, it is also possible that the tempo of development may vary, with four years encapsulating a time of exploration and commitment for some (Trajectory Category 3), and a slower path of exploration, perhaps with more constraints, leading to less certainty at the conclusion of the collegiate experience (Trajectory Categories 1 and 3). Indeed, scholars in other areas have drawn attention to tempo as a critical concept for understanding developmental trajectories (e.g., Meble, Harden, Brooks-Gunn, & Graber, 2010).

We also note that the two stable groups were quite small, which makes sense as we would expect movement and exploration during this developmental stage, and in the context of college. However, even within this stability, there are important developmental dynamics that we need to understand. For example, one can remain in a major despite changing interests and career goals with surface stability masking important dynamics. Trajectory Category Five is a nice example of the degree to which there can be surface stability but with important developments, particularly in terms of ethnic identity development.

Limitations and Future Directions

We intentionally chose to not take an explicitly intersectional lens to this analysis, though we did so in our interpretation of the data (Delucio & Villicana, 2021). Our intention was to conduct an exploratory close reading of all URM students potentially interested in pursuing STEM, with a small number of participants. However, other identity categories, such as gender, sexuality, and first generation status were also important. Given the complexity of taking a truly intersectional approach with a diverse group of students, one line of future inquiry is to shift the analysis to consideration of one racial or ethnic group to allow for an examination of the specific histories and experiences of each group (e.g., Gasman, Nguyen, Conrad, Lundberg, Commodore, 2017; McGee, Thakore, & LaBlance, 2017). For example, looking only at Native Americans, Montgomery et al. (2000) found that, amongst a variety of factors, maintaining a tribal sense of self for Native American college student was critical to success (see also Smith, Cech, Mertz, Huntoon, & Moyer, 2014). In terms of

intersectionality, researchers have emphasized how an aggregate view makes invisible the ways in which Black girls and women are both racialized and gendered in STEM contexts in which both characteristics are important. That is, both race/ethnicity and gender predict declaring a STEM major, but their intersection creates a uniquely marginalizing experience (e.g., Ireland, Freeman, & Winston-Proctor, DeLaine, McDonald Lowe, & Woodson, 2018), which some have called “intersectional invisibility” (Purdie-Vaughns & Eibach, 2008; see also Syed, Santos, Yoo, & Juang, 2018).

We also note that our sample may have been biased by the uneven distribution of gender. We did not include gender in our analyses, though it is a central issue in STEM research, and deserving of future inquiry from this kind of intensive longitudinal design. Overall, we emphasize that our data here are not meant to be generalizable to broader populations, but to guide theory-building and future research on the connection between major choice, psychological well-being, and identity formation.

Finally, we note that a possible limitation is the implicit biases two of us may hold as White college professors. What we value may be based on our own experiences as well as the cultures of the institutions where we work, which emphasize the value of a liberal arts education. In this context, major choice is expected to be very important to identity and to ideally reflect one’s passions and interests, a framework that may have biased what we saw, and looked for, in our analyses. We certainly became aware of it as we interpreted the results.

Conclusions

Though our focus was on URMs interested in STEM for important reasons, such as the obstacles these majors pose to these groups, we think our results speak more broadly to our understanding of college student development. As we considered how intimately linked major choice and career identity were to general psychological functioning, we thought about the two main branches of student services, and their separation, at least on our campuses: mental health counseling

and academic advising. The separation of these departments may orient us to adopt different hats when we work with students – the hat that is focused primarily on their well-being, and the hat that is charting course plans and volunteer and internship opportunities, etc. This separation may be creating a situation in which we miss necessary ties between their academic experiences and general functioning in relation to their broader life contexts (e.g., family), and the necessity of attending to both of these together to support positive identity development. Further, this attention to the whole person may be particularly important for students of color at predominantly white institutions where the campus structure and culture may be particularly harmful to the success and well-being of these students.

A contextualized identity approach to college student development cannot ignore the connections between these parts of our students' lives. And we only see these intersections when we follow our students intensively over time, making visible the impact of the major change on well-being and the reverse, the progressive feeling of being trapped in a major, or the ways in which parental expectations are negotiated across time. We see that some of our students have majors where they cannot be their best selves, something mental health counselors may be interested in. And the pressure and roles of family needs more attention from academic advisors.

On a concluding and more personal note, one of the many things that the COVID-19 pandemic has shifted for us, the first and third authors, is how we approach advising our students. As we look into the zoom boxes, into the rooms and homes of our students, their full lives become central to productive advising. How are they feeling? How are their families? Are they still working? Have their career hopes and plans changed? As we engaged with the results of this paper over the revision process, we realized how much we have shifted towards embracing a “whole person” approach to our work with our students, we hope leading towards better relationships with them, better guidance, and greater success for them. We hope the results of this project emphasize the importance of seeing the fullness of our students' lives as we work with them on their journeys

across the college years. The descriptions of these trajectory categories highlight a multitude of concerns that students face as they navigate this important developmental process, including the obstacles and affordances to access and support in pursuing a major that brings the person a sense of integration, meaning, and direction for the future.

References

- Arnett, J. J. (2000). Emerging adulthood: A theory of development from the late teens through the twenties. *American Psychologist*, 55(5), 469–480. <https://doi.org/10.1037/0003-066X.55.5.469>
- Arnett, J. J. (2006). *The Psychology of Emerging Adulthood: What Is Known, and What Remains to Be Known?* In J. J. Arnett & J. L. Tanner (Eds.), *Emerging adults in America: Coming of age in the 21st century* (p. 303–330). American Psychological Association. <https://doi.org/10.1037/11381-013>
- Azmitia, M., Syed, M., & Radmacher, K. A. (Eds.) (2008). *The intersections of personal and social identities: New Directions for Child and Adolescent Development*. San Francisco, CA: Jossey-Bass.
- Azmitia, M., Syed, M., & Radmacher, K. (2013). Finding your niche: Identity and emotional support in emerging adults' adjustment to the transition to college. *Journal of Research on Adolescence*, 23(4), 744–761. <https://doi.org/10.1111/jora.12037>
- Berzonsky, M. D. (2003). Identity style and well-being: Does commitment matter? *Identity: an International Journal of theory and Research*, 3(2), 131-142. <https://doi.org/10.1207/S1532706XID030203>
- Blagov, P. S., & Singer, J. A. (2004). Four dimensions of self-defining memories (specificity, meaning, content, and affect) and their relationships to self-restraint, distress, and repressive defensiveness. *Journal of Personality*, 72(3), 481-511. <https://doi.org/10.1111/j.0022-3506.2004.00270.x>
- Collins, P. H. (1990). *Black feminist thought: Knowledge, consciousness, and the politics of empowerment*. New York, NY: Routledge.
- Cooper, C. R., Chavira, G., & Mena, D. D. (2005). From pipelines to partnerships: A synthesis of research on how diverse families, schools, and communities support children's

- pathways through school. *Journal of Education for Students Placed at Risk*, 10(4), 407–430.
https://doi.org/10.1207/s15327671espr1004_4
- Creswell, J. W., Hanson, W. E., Clark Plano, V. L., & Morales, A. (2007). Qualitative research designs: Selection and implementation. *The counseling psychologist*, 35(2), 236-264.
<https://doi.org/10.1177/0011000006287390>
- Crocetti, E., Rubini, M., & Meeus, W. (2008). Capturing the dynamics of identity formation in various ethnic groups: Development and validation of a three-dimensional model. *Journal of adolescence*, 31(2), 207–222. <https://doi.org/10.1016/j.adolescence.2007.09.002>
- Delucio, K., & Villicana, A. J. (2020). Intersectionality as an analytic sensibility in cultural research. To appear in K.C. McLean (Ed), *Cultural Methodologies in Psychology: Describing and Transforming Cultures*. Oxford University Press.
- Easterbrook M. J., & Hadden, I. R. (2021). Tackling educational inequalities with social psychology: Identities, contexts, and interventions. *Social Issues and Policy Review*, 15(1), 180—236.
<https://doi.org/10.1111/sipr.12070>
- Erikson, E.H. (1968). *Identity: youth and crisis*. New York: Norton & Co.
- Estrada, M., Woodcock, A., Hernandez, P. R., & Schultz, P. W. (2011). Toward a model of social influence that explains minority student integration into the scientific community. *Journal of Educational Psychology*, 103(1), 206–222. <https://doi.org/10.1037/a0020743>
- Estrada, M., Hernandez, P. R., & Schultz, P. W. (2018). A longitudinal study of how quality mentorship and research experience integrate underrepresented minorities into STEM careers. *CBE—Life Sciences Education*, 17(1), ar9. <https://doi.org/10.1187/cbe.17-04-0066>
- Galliher, R. V., McLean, K. C., & Syed, M. (2017). An integrated developmental model for studying identity content in context. *Developmental Psychology*, 53(11), 2011-2022.
<https://doi.org/10.1037/dev0000299>
- Gasman, M., Nguyen, T.-H., Conrad, C. F., Lundberg, T., & Commodore, F. (2017). Black male

- success in STEM: A case study of Morehouse College. *Journal of Diversity in Higher Education*, 10(2), 181–200. <https://doi.org/10.1037/dhe0000013>
- Ghavami, N., Katsiaficas, D., & Rogers, L. O. (2016). Toward an intersectional approach in developmental science. The role of race, gender, sexual orientation, and immigrant status. *Advances in Child Development and Behavior*, 50, 31-73. <https://doi.org/10.1016/bs.acdb.2015.12.001>
- Hawley, C. E., Cardoso, E., & McMahon, B. T. (2013). Adolescence to adulthood in STEM education and career development: The experience of students at the intersection of underrepresented minority status and disability. *Journal of Vocational Rehabilitation*, 39(3), 193-204. <https://doi.org/10.3233/JVR-130655>
- Herle, M., Micali, N., Abdulkadir, M. *et al.* Identifying typical trajectories in longitudinal data: modelling strategies and interpretations. *Eur J Epidemiol* **35**, 205–222 (2020).
<https://doi.org/10.1007/s10654-020-00615-6>
- Hernandez, P. R., Schultz, P., Estrada, M., Woodcock, A., & Chance, R. C. (2013). Sustaining optimal motivation: A longitudinal analysis of interventions to broaden participation of underrepresented students in STEM. *Journal of Educational Psychology*, 105(1).
<https://doi.org/10.1037/a0029691>
- Hurtado, S., Han, J. C., Sáenz, V. B., Espinosa, L. L., Cabrera, N. L., & Cerna, O. S. (2007). Predicting transition and adjustment to college: Biomedical and behavioral science aspirants' and minority students' first year of college. *Research in Higher Education*, 48, 841–887.
<https://doi.org/10.1007/s11162-007-9051-x>
- Ireland, D. T., Freeman, K. E., Winston-Proctor, C. E., DeLaine, K. D., McDonald Lowe, S., & Woodson, K. M. (2018). (Un)Hidden figures: A synthesis of research examining the intersectional experiences of black women and girls in STEM education. *Review of Research in Education*, 42(1), 226-254. <https://doi.org/10.3102/0091732X18759072>

- Johnson, DR. (2012). Campus racial climate perceptions and overall sense of belonging among racially diverse women in STEM majors. *Journal of College Student Development*, 53(2), 336–346.
<https://doi.org/10.1353/csd.2012.0028>
- Josselson, R. (2009). The present of the past: Dialogues with memory over time. *Journal of Personality* 77(3):647-68. <https://doi.org/10.1111/j.1467-6494.2009.00560.x>
- La Guardia, J. G. (2009). Developing who I am: A self-determination theory approach to the establishment of healthy identities. *Educational Psychologist*, 44(2), 90-104.
<https://doi.org/10.1080/00461520902832350>
- Levitt, H. M., Bamberg, M., Creswell, J. W., Frost, D. M., Josselson, R., & Suárez-Orozco, C. (2018). Journal article reporting standards for qualitative primary, qualitative meta-analytic, and mixed methods research in psychology: The APA Publications and Communications Board task force report. *American Psychologist*, 73(1), 26-46. <http://dx.doi.org/10.1037/amp0000151>
- Lilgendahl, J. P. (2015). The dynamic role of identity processes in personality development: Theories, patterns, and new directions. In K. C. McLean & M. Syed (Eds.), *Oxford library of psychology. The Oxford handbook of identity development* (p. 490–507). Oxford University Press.
- Lilgendahl, J. P., & McLean, K. C. (2020). Narrative Identity Processes and Patterns of Adjustment Across the Transition to College: A Developmentally Contextualized Approach. *Journal of Personality and Social Psychology*. 119(4), 960-977. <http://dx.doi.org/10.1037/pspp0000277>
- Love, D. (2009). Student retention through the lens of campus climate, racial stereotypes, and faculty relationships. *Journal of Diversity Management (JDM)*, 4(3), 21-26.<https://doi.org/10.19030/jdm.v4i3.4962>
- Luyckx, K., Klimstra, T. A., Schwartz, S. J., & Duriez, B. (2013). Personal identity in college and the work context: Developmental trajectories and psychosocial functioning. *European Journal of Personality*, 27(3), 222-237. <https://doi.org/10.1002/per.1903>
- Mack, K.M., Rankins, C. M., & Winston, C. E. (2011). Black women faculty at Historically Black Colleges

- and Universities: Perspectives for a national imperative. In H.T. Frierson & W.F. Tate (Eds.), *Beyond stock stories and folk tales: African Americans' paths to STEM fields (Diversity in Higher Education, Volume 11)* (pp. 149-164). Bingley, UK: Emerald Group Publishing Limited.
- MacPhee, D., Farro, S., & Canetto, S. S. (2013). Academic self-efficacy and performance of underrepresented STEM majors: Gender, ethnic, and social class patterns. *Analyses of Social Issues and Public Policy (ASAP)*, 13(1), 347-369. <https://doi.org/10.1111/asap.12033>
- Marcia, J. E. (1967). Ego identity status: Relationship to change in self-esteem, “general maladjustment”, and authoritarianism. *Journal of Personality*, 35(1), 119–133. <https://doi.org/10.1111/j.1467-6494.1967.tb01419.x>
- McAdams, D. P., & McLean, K. C. (2013). Narrative identity. *Current Directions in Psychological Science*, 22(3), 233–238. <https://doi.org/10.1177/0963721413475622>
- McGee, E. O., Thakore, B. K., & LaBlance, S. S. (2017). The burden of being “model”: Racialized experiences of Asian STEM college students. *Journal of Diversity in Higher Education*, 10(3), 253–270. <https://doi.org/10.1037/dhe0000022>
- Meble, J., Harden, K. P., Brooks-Gunn, J., & Graber, J. A. (2010). Development's tortoise and hare: pubertal timing, pubertal tempo, and depressive symptoms in boys and girls. *Developmental psychology*, 46(5), 1341-1353. <https://doi.org/10.1037/a0020205>
- Mills, K. J. (2020). “It’s systemic”: Environmental racial microaggressions experienced by Black undergraduates at a predominantly White institution. *Journal of Diversity in Higher Education*, 13(1), 44–55. <https://doi.org/10.1037/dhe0000121>
- Montgomery, D., Miville, M. L., Winterowd, C., Jeffries, B., & Baysden, M. F. (2000). American Indian college students: An exploration into resiliency factors revealed through personal stories. *Cultural Diversity and Ethnic Minority Psychology*, 6(4), 387–398. <https://doi.org/10.1037/1099-9809.6.4.387>
- Nasir, N. I. S., & Shah, N. (2011). On defense: African American males making sense of racialized

- narratives in mathematics education. *Journal of African American Males in Education (JAAME)*, 2(1), 24-45.
- National Science Foundation, National Center for Science and Engineering Statistics. 2019. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2019*. Special Report NSF 19-304. Alexandria, VA. Available at <https://www.nsf.gov/statistics/wmpd>.
- Pasupathi, M., Mansour, E., & Brubaker, J. (2007). Developing a life story: Constructing relations between self and experience in autobiographical narratives. *Human Development*, 50, 85–110. <https://dx.doi.org/10.1159/000100939>
- Patall, E. A., Cooper, H., & Robinson, J. C. (2008). The effects of choice on intrinsic motivation and related outcomes: A meta-analysis of research findings. *Psychological Bulletin*, 134(2), 270–300. <https://doi.org/10.1037/0033-2909.134.2.270>
- Perez, T., Cromley, J. G., Kaplan, A. (2014). The role of identity development, values, and costs in college STEM retention. *Journal of Educational Psychology*, 106(1), 315-329. <https://doi.org/10.1037/a0034027>
- Purdie-Vaughns, V., & Eibach, R. P. (2008). Intersectional invisibility: The distinctive advantages and disadvantages of multiple subordinate-group identities. *Sex Roles: A Journal of Research*, 59(5-6), 377–391. <https://doi.org/10.1007/s11199-008-9424-4>
- Robnett, R. D., Nelson, P. A., Zurbriggen, E. L., Crosby, F. J., & Chemers, M. M. (2018). Research mentoring and scientist identity: insights from undergraduates and their mentors. *International Journal of STEM Education*, 5(1), 41. <https://doi.org/10.1186/s40594-018-0139-y>
- Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55(1), 68–78. <https://doi.org/10.1037/0003-066X.55.1.68>
- Schachter, E. P. (2004). Identity configurations: A new perspective on identity formation in contemporary society. *Journal of Personality*, 72(1), 167 – 200. <https://doi.org/10.1111/j.0022-3506.2004.00260.x>

- Seymour, E., & Hewitt, N. M. (1997). *Talking about leaving: Why undergraduates leave the sciences*. Boulder, CO: Westview Press.
- Shillingford, M. A., Oh, S., & Finnell, L. R. (2017). Promoting STEM career development among students and parents of color: Are school counselors leading the charge?. *Professional School Counseling, 21*(1b). <https://doi.org/10.1177/2156759X18773599>
- Smith, J. L., Cech, E., Metz, A., Huntoon, M., & Moyer, C. (2014). Giving back or giving up: Native American student experiences in science and engineering. *Cultural Diversity and Ethnic Minority Psychology, 20*(3), 413–429. <https://doi.org/10.1037/a0036945>
- Syed, M. (2010). Developing an integrated self: Academic and ethnic identities among ethnically diverse college students. *Developmental Psychology, 46*(6), 1590–1604. <https://doi.org/10.1037/a0020738>
- Syed, M., Azmitia, M., & Cooper, C. R. (2011). Identity and academic success among under-represented ethnic minorities: An interdisciplinary review and integration. *Journal of Social Issues, 67*(3), 442–468. <https://doi.org/10.1111/j.1540-4560.2011.01709.x>
- Syed, M., & McLean, K. C. (2016). Understanding identity integration: Theoretical, methodological, and applied issues. *Journal of adolescence, 47*, 109–118. <https://doi.org/10.1016/j.adolescence.2015.09.005>
- Syed, M., Santos, C., Yoo, H. C., & Juang, L. P. (2018). Invisibility of racial/ethnic minorities in developmental science: Implications for research and institutional practices. *American Psychologist, 73*(6), 812–826. <https://doi.org/10.1037/amp0000294>
- Tajfel, H., & Turner, J. C. (2004). The Social Identity Theory of Intergroup Behavior. In J. T. Jost & J. Sidanius (Eds.), *Key readings in social psychology. Political psychology: Key readings* (p. 276–293). Psychology Press. <https://doi.org/10.4324/9780203505984-16>
- U.S. Census Bureau (2010). Retrieved from <https://data.census.gov/cedsci/table?q=United%20States&tid=DECENNIALPLNAT2010.P1&hidePreview=false>.

- Vosylis, R., Erentaitė, R., Crocetti, E. (2018). Global versus domain-specific identity processes: which domains are more relevant for emerging adults?. *Emerging adulthood*, 6(1), 32-41.
<http://doi.org/10.1177/2167696817694698>.
- Woldoff, R., Wiggins, Y., & Washington, H. (2011). Black Collegians at a Predominantly White Institution: Toward a Place-Based Understanding of Black Students' Adjustment to College. *Journal of Black Studies*, 42(7), 1047-1079. <http://www.jstor.org/stable/41304573>
- Wertz, F. J., Charmaz, K., McMullen, L. M., Josselson, R., Anderson, R., & McSpadden, E. (2011). *Five ways of doing qualitative analysis: Phenomenological psychology, grounded theory, discourse analysis, narrative research, and intuitive inquiry*. The Guilford Press.
- Winston, C. E., Wall Rice, D., Bradshaw, B. J., Lloyd, D., Harris, L. T., Burford, T. I., ... & Burrell, J. (2004). Science success, narrative theories of personality, and race self complexity: Is race represented in the identity construction of African American adolescents?. *New Directions for Child and Adolescent Development*, 2004(106), 55-77. <https://doi.org/10.1002/cd.116>

Table 1. Participant Descriptions: By Category

Trajectory Category	Ethnicity	Gender	Campus	STEM status
1	White/Latinx	Female	1	non-STEM
1	Black	Female	1	STEM
1	White/Latinx/Asian	Female	2	non-STEM
2	Black	Male	1	STEM
2	White/Black/Native Am	Male	2	STEM
3	Latinx	Male	1	non-STEM
3	White/Latinx	Male	1	non-STEM
3	White/Latinx/Asian	Female	2	STEM
3	White/Latinx	Female	1	STEM
3	White/Latinx	Unknown	2	non-STEM
3	White/Latinx/Asian	Female	2	STEM
4	Latinx	Female	1	STEM
4	Latinx	Male	1	non-STEM
4	White/Latinx	Female	2	non-STEM
4	Black	Male	2	non-STEM
4	White/Latinx	Female	1	non-STEM
4	Latinx	Female	2	non-STEM
4	White/Latinx	Male	2	non-STEM
5	White/Latinx/Native Am	Female	2	non-STEM
5	Latinx	Female	2	non-STEM
5	White/Black	Male	1	STEM
5	Arab	Female	1	non-STEM
5	Latinx	Female	1	non-STEM
5	Black	Female	1	STEM
5	White/Native Am	Female	2	STEM
5	Black	Female	2	non-STEM

Note. STEM status is based on participants' major at graduation.