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The science identity and entering a science occupation

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ABSTRACT

The initiative to increase the number of students in STEM disciplines and train them for a science-related job is a current national focus. Using longitudinal panel data from a national study that followed underrepresented college students in STEM fields, we investigate the neglected role that social psychological processes play in influencing science activity among the young. We study the impact of identity processes related to being a science student on entering a science occupation. More broadly, we examine whether an identity formulated in one institutional setting (education) has effects that persist to another institutional setting (the economy). We find that the science identity positively impacts the likelihood of entering a science occupation. It also serves as a mediator for other factors that are related to educational success. This provides insight into how an identity can guide behavior to move persons into structural positions across institutional domains.

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1. Introduction

Improving the rate at which individuals enter into and remain in a career in science remains a national concern. For example, in 2010, as part of his “Educate to Innovate” campaign, President Obama announced an initiative wherein select major companies, universities, and government agencies would partner to prepare more than 10,000 new teachers in science and math, and support the professional development of more than 100,000 current teachers in science, technology, engineering, and mathematics (STEM) by 2015 ([White House Press Secretary, 2010](#)). The U.S. lags behind other nations in STEM education, and Obama’s objective in addressing the teacher shortage in STEM was to raise America as a leader internationally in STEM achievement. Jobs in STEM are anticipated to be a major area of future growth and, coupled with the higher earnings in this area, it seems wise to educate more youth into the STEM fields ([Bureau of Labor Statistics, \(2012\)](#)).

Women and racial minorities historically have been underrepresented in higher education, especially STEM fields. For example, recent data reveals that Blacks and Latino/as comprised less than 10% of all doctoral degrees in STEM fields ([National Science Foundation, 2012](#)). Since racial minorities will continue to comprise a larger proportion of the US population rise (over 40% will be Black or Latino/a by 2045) ([United States Census Bureau, 2012](#)), it is important that efforts are made to increase the participation of minorities in STEM fields so that we may have an adequate number of qualified STEM workers.

One way to increase minority participation in STEM occupations is to develop enrichment programs in colleges that will help channel students into these fields. These programs facilitate the development of skills that increase the rate at which

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students will retain an interest in science during college and enter a science-related occupation rather than leaking out of the scientific pipeline (Schultz et al., 2011). While involvement in science enrichment programs helps, what also may be important is whether individuals see themselves as a “science” student such that they enact behaviors consistent with this characterization. Here we refer to people as having a “science identity.”

The idea that the science identity is an important factor producing minority students' involvement in science has received some attention (Carlone and Johnson, 2007; Lee, 1998, 2002; Merolla and Serpe, 2013; Merolla et al., 2012). However, the outcomes examined in many of these studies is “developing an interest in” or an “intention to pursue” a STEM career. We extend this line of work in several ways. First, rather than focusing on whether minority students retain an interest in science during the schooling years, or whether they intend to pursue a science-related career after they have graduated, we examine whether they enter a science-related occupation upon leaving the education setting. While interest and intention are important (and we include intention in our current analysis), leaking out of the pipeline may still occur. Thus, we study the impact that the identity process has on obtaining work in a science field in the economy.

Second, we study different but interrelated dimensions of the identity process during the school years as they impact obtaining a science occupation (Stets and Serpe, 2013). These include seeing oneself as having a science identity, holding the science identity as important to oneself (identity prominence), and experiencing verification (or the lack thereof) of the science identity during the school years. Focusing on these multiple dimensions of the identity process and applying it to the education setting advances the theoretical development of identity theory (Stryker and Burke, 2000) as well as identifies the dimensions of one's science identity that importantly influence obtaining a science occupation.

Third, we study these identity processes while controlling for other processes that may be theoretically relevant in understanding achievement in STEM education. Specifically, we operationalize self-efficacy theory (Bandura, 1997), goal theory (Covington, 2000), and attitude theory (Fishbein and Ajzen, 1975) as alternative explanations for entering a science career. We find that even controlling for these alternative processes, the science identity that is formulated in the educational system increases the likelihood of channeling minority students into a science occupation. To show this, we use data from five waves of a national panel study that followed underrepresented college students involved in a STEM-related program. Data collection began in 2005 and ended in 2013. The multiple waves of data consist of repeated measures on all of the variables. A total of 966 participants are followed across ten waves.

2. Theory

2.1. Identity theory

An identity is a set of meanings that define who a person is in terms of their roles (role identities), group or category memberships (social identities), or as unique individuals (person identities) (Burke and Stets, 2009). Our approach focuses on the science identity as a role identity given an individual's occupancy of the student role. We are interested in minority students defining themselves as science students. What does it mean, for example, to be a science student? In general, it is understood that the meanings that define the identity are portrayed in behavior that emanates from the identity. A person who thinks of herself as a science student will act in ways that convey these meanings to others as well as to herself. To the extent that minority students see themselves as “very good” or “excelling” as science students, they can be conceptualized as having a higher science identity standard compared to those who see themselves as “not at all good” or “failing” as a science student.

The science identity matters for some important student outcomes. Research reveals that for minority students, the science identity is related to students' interest in science, their persistence or tenacity in a science discipline, their intention to pursue a scientific career, and even their decision to enter a graduate science program (Lee, 1998; Merolla and Serpe, 2013; Merolla et al., 2012). While previous research has revealed that persistence in science as a field of study during the school years requires mastering the skills and activities related to science, also important is that individuals see themselves in terms of being a student of science; that is, having a science identity (Carlone and Johnson, 2007; Lee, 1998, 2002; Merolla et al., 2012). However, it is unclear whether science outcomes in school translate into taking on work in the economy that is science-related. We examine science-related employment to evaluate the impact that minority students' self-views as students of science (the science identity) has on the work that they do once they leave the educational setting.

A long-standing tenet of identity theory is that the meanings that individuals attribute to themselves should correspond to the meanings implied by how they behave in situations (Burke and Reitzes, 1981). If we did not know people's identity, observing their behavior and the meanings evoked through it would give us a sense as to their underlying identity. Research evidences the link between one's identity and behavior that corresponds to it (Burke, 2003; Burke and Reitzes, 1981; Reitzes and Burke, 1980; Riley and Burke, 1995; Stryker and Serpe, 1982). Given this, we hypothesize that among these primarily minority students:

H1: The higher the students' science identity, the more likely they will be to enter a science occupation.

Since identities are comprised of different dimensions that are internally experienced, we investigate not only how individuals see themselves in terms of being a science student (the science identity), but also the prominence/importance of their science identity, and the degree to which their science identity is verified in situations. Identity prominence refers to the

importance of an identity to a person; it is how individuals would like to see themselves given their ideals (McCall and Simmons, 1978), or what is central to them (Rosenberg, 1979). Some also have defined prominence as people's subjective sense of an identity's worth or value to them (Ervin and Stryker, 2001). Identity prominence has an important link to behavior; the more important an identity is to a person, the more it should guide behavior that corresponds in meaning to the identity. Research shows a positive relationship between the prominence of the identity and behavior (Stryker and Serpe, 1994), and the probability of enacting behavior consistent with a prominent identity (Brenner et al., 2014). Consequently, we predict that for the students in our current sample:

H2: The higher the prominence of the students' science identity, the more likely they will enter a science occupation.

While identities provide meaning and direction to behavior, this behavior serves as the basis for others' interpretation as to the identities people claim in a situation. When individuals receive feedback from others that others see them in the same way that they see themselves in terms of their identity (reflected appraisal), their identity is verified, they will feel good about themselves, and feeling good reinforces the behavior that was based on their identity (Burke and Stets, 2009). When feedback or the appraisals of others reflected back onto individuals indicates that others do not share their self-view, peoples' identities are not verified, they will feel bad, and this motivates them to change their behavior in order to influence others' views to be more consistent with their own self-views.

In this study, the difference between how individuals see themselves as a science student (their science identity), and how they think others see them as a science student (reflected appraisals) is the degree to which a discrepancy in the science identity exists. When the discrepancy is at zero, there is identity verification. The more the departure from zero in either a negative or positive direction, the more individuals experience identity non-verification. If the discrepancy is in a positive direction, others see science students as "better" at being a science student than how the students see themselves. If the discrepancy is in a negative direction, others see the science students as "worse" at being a science student than how the students see themselves.

Consistent with the above discussion, when the science identity discrepancy is in a positive direction, we expect that students will be less likely to plan and pursue a science career in an effort to reduce the discrepancy and counteract others' overly positive views (Burke and Stets, 2009). Essentially, they won't work as hard to behave in ways consistent with their science identity including pursuing a science occupation because others are seeing them as better at the science identity than how they see themselves; this is distressful because it may set up expectations that are too high for themselves to meet. If the science identity discrepancy is in a negative direction, students should be more likely to plan and pursue a science career to counteract the discrepancy and communicate an identity that is more positive than how others see them. Essentially, the goal is to reassert who one is to others. Therefore, our final hypothesis is that among the primarily minority students:

H3: The more positive the students' science identity discrepancy, the less likely they will enter a science occupation; the more negative the students' science identity discrepancy, the more likely they will enter a science occupation.

Overall, the different dimensions of the science identity are self-perceptions of being a science student. However, it is important to measure performance in being a science student. For this, we will use the student's grade point average (GPA). Controlling for GPA will enable us to examine whether the science identity and the dimensions related to it influence entering a science occupation in the economy net of the effects of GPA.

The hypothesized relationships between the identity processes and entering a science occupation are also net of the effect of alternative theoretical processes that may be relevant. These include the role of self-efficacy, performance-approach and performance-avoidance goal orientations, and behavioral intentions to pursue a science occupation. It also is net of other effects that occur while in school such as engaging in science activities as well as being mentored by someone in the science field. We discuss these alternative processes below. Since they serve as controls in our model and we are primarily interested in the effects of the identity process, we do not provide formal hypotheses, although we do indicate the expected direction of effects.

2.2. Other theoretical processes and social factors

Self-efficacy theory addresses people's confidence in their ability to carry out behaviors that achieve a particular goal (Bandura, 1997). For Bandura, efficacy expectations are individuals' belief that they can perform the behaviors necessary to produce a particular outcome, influence the course of action they chose, control how much effort they put forth, and regulate how long they persist. As applied in the educational setting, self-efficacy can be predictive of academic performance in science. The more confident minority students are in their ability to pass a science test or produce a set of scientific results through theoretical and empirical work, the more likely it is that they will decide to enter a science career. Consequently, we expect that higher self-efficacy in science should lead to entering a science occupation.

If self-efficacy influences the actions people take, people's goals also should give direction to behavior. One set of goal orientations that has received attention in achievement situations like the school setting are performance goals in which people demonstrate their competence relative to others (Elliot, 1999). There are two orientations within performance goals: an approach orientation and an avoidance orientation (Kaplan and Maehr, 2007). In an approach orientation, individuals want

to show they have high ability relative to others. The focus is on showing success. In an avoidance orientation, persons are concerned about showing low ability relative to others, so they work to avoid demonstrating this. The focus is on avoiding failure. A performance approach goal is related to such positive outcomes as persistence while studying and high-performance outcome, and a performance avoidance goal is more likely to be associated with negative outcomes such as shallow processing of information, poor retention of information, and poor performance (Elliot, 1999). Thus, we anticipate a performance approach goal will be positively associated with choosing a science-related career, and a performance avoidance goal will be negatively associated with choosing a science occupation for the students in our sample.

Still another factor that may give direction to behavior is one's intentions. In the literature on attitudes, the theory of reasoned action maintains that a proximal attitude toward a behavior, that is, people's intention to act in a particular way, is a stronger antecedent to behavior than a distal antecedent such as people's attitude (positive or negative) on their behavior (Ajzen and Fishbein, 2005). Attitudes influence behavior by influencing one's intention to behave in a particular manner. Essentially, since people are presumed to behave in a way that they intend, there is an inherent "reasonableness" to their action. We expect this same process to apply to science-related behavior. Students who indicate a higher intention to pursue a science-related career should be more likely to enter a science-related occupation compared to students who indicate a lower intention.

We point out that there are researchers who may integrate many of the processes we've already outlined: one's identity, confidence, goals, and intentions. An integrated theory that comes closest to doing this is expectancy-value theory (Wigfield and Eccles, 2000; Eccles and Wigfield, 2002). It integrates expectancies of success (confidence in one's ability to succeed) with the values that people attach to their achievement-related behaviors, for example, intrinsic value as well as utility value, to explain the choices and performances individuals enact. More recently, Eccles (2009) gives attention to the role of personal and social/collective identities in the expectancy-value model. She argues that one's identities can influence and be influenced by one's feeling of efficacy or expectation of success. Further, rather than values undergirding people's behaviors, what becomes important is how behaviors are influenced by personal and collective identities as well as influence the expression of personal and collective identities. While social identities are important and shape expectancies and values, we argue that role identities also are important. Thus, we examine how the science role identity increases the likelihood of pursuing a science occupation.

The role of being a science student should involve engaging in science-related activities in school, such as conducting research, presenting the results, and publishing them. Such activities should not only reinforce the science role identity, but also prepare individuals for the position of holding a science occupation in the economy. Therefore, we anticipate that science-related behaviors in schools should lead to entering a science occupation.

What also may prepare individuals for a science job is obtaining additional learning and expertise in school from a science mentor. Indeed, prior research reveals that mentoring is positively related to student persistence, retention rates, academic performance (GPA), and increased engagement in campus life, all of which increase students' academic success (Crisp and Cruz, 2009; Haring, 1999; Kardash, 2000) including the success of underrepresented groups (Burke, 1996; Strayhorn and Saddler, 2009; Strayhorn and Terrell, 2007). Research finds that mentoring is integral to minorities in STEM disciplines both in terms of their academic success (Harsh, 2011; Hernandez et al., 2013; Hurtado et al., 2009) and future plans for graduate school and a science career (Carter et al., 2009; Estrada et al., 2010; Lopatto, 2007; Merolla and Serpe, 2013; Myers and Pavel, 2011). The instrumental support that mentoring offers science students, and the knowledge and skills that the students obtain, can help advance science students toward the goal of a science occupation.

In summary, we are interested in whether one's role identity in one institution (here, the science identity in the educational system) influences the choices one makes in another institution (entering a science occupation in the economy). To properly examine the impact of one's identity on entering a science occupation, we control for GPA and other theoretical processes discussed above that prior research suggests are relevant for success in being a science student in the educational system, and by extension, would influence the choice to enter a science occupation. These include feelings of self-efficacy in science, one's performance orientation, one's intention to pursue a science-related field, engagement in science activities, and support of a mentor in science. We also control for key demographic factors including the level of education of the participants' parents, and the race and gender of the participants.

3. Method

3.1. Sample

The participants come from five waves of panel data from *TheScienceStudy*, a national panel study that followed underrepresented college students in STEM fields (Schultz, 2005–2013). Students were recruited from universities that had a NIH-funded Research Initiative for Scientific Enhancement (RISE) training program. Many of these universities also had the following training programs: Minority Access to Research Careers (MARC), Undergraduate Student Training in Academic Research (U*STAR), and Bridges programs (Brenner et al., 2014; Merolla et al., 2012; Schultz et al., 2011). The goal of these science-training programs was to increase the number of minorities pursuing science careers.

At the time the sample was recruited, there were 38, four-year institutions with an NIH-Funded RISE program. All 38 universities were invited to participate. *TheScienceStudy* obtained data from students from 25 of the 38 universities. The participating institutions included private and public; small, medium, and large institutions; and campuses from 17 states

that represented a diverse mix including historically black colleges, Hispanic-serving institutions, and multicultural campuses.

Study participants were surveyed biannually (fall and spring semester) with data collection beginning with an initial screen in the fall semester of 2005 (wave 0) through spring 2013 (wave 15). The initial sample (wave 0) consisted of students who were either members of one of the training programs, or they were recruited from a sample of students who initially were not members one of the training programs, but whose student profile matched the training program students on 11 background variables. These background variables included age, gender, race/ethnicity, GPA, major, school, intention to pursue a scientific research career, educational progress (e.g., lower or upper division undergraduate, master's, or doctoral student), English as a first language, first generation attending college, and transfer status (from a community or junior college).

The sample of students from the training programs was obtained with the assistance of each campus's program staff who identified the students who were in the program. The matched sample was recruited from students enrolled in upper-division gateway science courses at the 25 campuses. All students were majoring in a STEM discipline and expressed interest in pursuing a science-related research career. We define STEM disciplines using the rubric of federal agencies, like NSF that include the natural, biological, medical, social, and behavioral sciences, mathematics, engineering, and technological fields (Gonzalez and Kuenzi, 2012). To construct the matched sample, 2166 students from the upper-division gateway science courses filled out an initial screening questionnaire providing information on the 11 background variables. A propensity score matching procedure was used to identify those students who matched the training program sample (Rosenbaum and Rubin, 1984; West et al., 2008). Thus, in wave 0, the initial screening of students, some were in the funded programs, and others were not in the funded programs but were matched to the students in the funded programs on the 11 characteristics. In wave 1, some students dropped out, and some were added who were members of funded programs as well as matched students. In wave 2, more students were added from funded programs. After wave 2, no more students were added to the panel design.

The final sample consists of 1420 participants; 622 students from the training programs and 798 from the matched sample (Schultz et al., 2011). We remove from our sample 454 participants who are missing all data on all measured scales in waves 6 and 8. Using a full-information maximum likelihood estimation procedure, which uses all of the available data for analysis, there are a total of 966 students who have at least partial data on our variables of interest over four waves: waves 4, 6, 8, and 10 (collected in the fall of 2007, 2008, 2009, and 2010). We use these waves because they track most students as they go through the program and obtain their first job. Wave 10 has only the science occupation variable. Thus, wave 8 is our final sample that has the variables of interest and that lead to the prediction of the science occupation in wave 10. By wave 8, 71% of the original sample (wave 0) are still participating in the study.¹ Of the 966 students we study, 57% of the students ($N = 554$) are in a science-training program over the course of the five waves we use compared to 43% ($N = 412$) who are not in such a program.

An analysis of the data reveal that there are no differences in the gender composition ($\chi^2 = 0.83$, ns), ethnicity makeup ($\chi^2 = 7.7$, ns), or level of parent's education ($\chi^2 = 0.92$, ns) for the later sample of students (wave 8) compared to the earlier sample (wave 1). Additionally, comparing the later sample of students with the earlier sample of students, there are no differences in terms of the levels in the science identity ($t = 0.13$, ns), identity discrepancy ($t = 0.24$, ns), mentoring ($t = 1.90$, ns), performance approach behavior ($t = 1.26$, ns), or performance avoidance behavior ($t = 1.47$, ns). There are differences in the two samples on the remaining variables. Students report higher prominence of the science identity ($t = 2.89$, $p < 0.05$) and a higher science self-efficacy ($t = 3.00$, $p < 0.05$) in wave 8, but they report lower science behavior ($t = 3.37$, $p < 0.05$) and a decline in the intention to pursue a science-related research career ($t = 6.44$, $p < 0.05$) in wave 8.

We examine whether the differences we observe in the two samples are due to individuals simply changing over time. For this, we run paired t-tests for individuals who are in wave 1 and remain in the sample by wave 8. The results reveal that the differences are due to individuals changing their levels on each of these variables over time. The prominence of individuals' science identity increases over time ($t = 2.30$, $p < 0.05$) as does their science self-efficacy ($t = 3.95$, $p < 0.05$). They report lower science behavior ($t = 3.77$, $p < 0.05$) and a decline in the intention to pursue a science-related career ($t = 6.87$, $p < 0.05$) over time. Therefore, we conclude that there are no significant differences in students who initially enter to the study compared to those who remain in the study over time. Any differences that are observed are due to individuals who remain in the study changing over time.

Since the study is designed to increase the number of women and minorities who enter STEM-related careers, we ask whether our sample is representative of the typical minority science student. We find that when comparing our sample with recent national data, our sample over-represents women by about 15% (National Science Foundation, 2016). Nationally, the number of women in STEM majors in 2006 was 57.1% compared to our sample total of 71.5% in 2006 (wave 1). While this is an over-representativeness of women, at issue is whether this introduces a bias into our analysis.

¹ The sample was recruited and maintained by the Tailored Panel Management (TPM) design, a methodology developed to manage longitudinal research designs (Estrada et al., 2014). TPM is designed to increase response rates and reduce attrition of panel participants by increasing the participant's commitment to the study. It is based on a strategy of keeping the participants engaged, which includes communication, consistency, compensation, and credibility of the study. Participants were removed from the sample at their request, or if they failed to complete a survey over three consecutive waves of data collection.

We examine whether the higher proportion of women produce better students in our sample than the typical STEM student. Other research reveals that for female STEM students entering college, their average high school GPA is 3.5 (Cole and Espinoza, 2009). In our data, women report an average high school GPA of 3.53. African American women report an average high school GPA of 3.49 and Latinas report a 3.58. Thus, these women do not appear to be better students compared to the typical female entering STEM.

We also examine women's intention to enter a science-related research career. According to recent data, in 2006 (wave 1 of this study), 27.2% of all entering college women intended to major in science and engineering; among African American women, 31.9% reported a science and engineering major, and among Latinas 34% reported this major (National Science Foundation, 2016). In our sample, 37.1% of the women (wave 1) report that they intend on pursuing a science-related research career. For African American women, it is 37.2 and for Latinas, it is 38.7. Thus, the women in our sample are slightly more motivated to pursue science as a career. However, the results that we later report reveal that people's intention to enter a science career is not associated with them actually entering a science-related field.

3.2. Measures

3.2.1. Dependent measure

The outcome construct for this study, *science occupation*, is assessed by a single-item indicator in which participants who are not enrolled in school are asked whether their current occupation is in a science-related field or not (coded 0/1). We measure this at wave 10 to give most students sufficient time to get through college and obtain their first job.

3.2.2. Independent measures

3.2.2.1. Identity measures.

3.2.2.1.1. *Science identity*. The science identity construct is a single indicator. Individuals report their self-view as a science student. Participants indicate how they rate themselves as a science student. Response categories are “Not at all good” to “Very good” (coded 0–10). A higher score on the science identity reflects a more positive self-view as a science student.

3.2.2.1.2. *Science identity prominence*. Four indicator variables assess how prominent the science identity is to participants. Individuals indicate how much they agreed with each of the following statements: “In general, being a scientist is an important part of my self-image.”; “I have a strong sense of belonging to the community of scientists.”; “Being a scientist is an important reflection of who I am.”; and “I have come to think of myself as a ‘scientist.’” Response categories are “Strongly Disagree” to “Strongly Agree” (coded 1–5). As shown in Table 1, the items are factor analyzed using principle components analysis. The items form a single scale with a high reliability. The items are summed and divided by the number of items participants answer (if they are missing). This produces an average score on the scale. A higher score represents a more prominent science identity. The scale has an omega reliability of 0.92.

3.2.2.1.3. *Science identity discrepancy*. Two constructs comprise the science identity discrepancy: the science identity measure (described above) and a reflected appraisal measure. For the reflected appraisal measure, participants report how they think members of each of the following four categories rate them as a science student: their family, coworkers, friends, and girlfriend/boyfriend/spouse/partner. Response categories are “Not at all good” to “Very good” (coded 0–10). In Table 1, we see that the items form a single scale with an omega reliability of 0.89. We average the four views to create an overall score of others' views (reflected appraisals).

We compute the science identity discrepancy indicator by subtracting individuals' science identity score from the overall score of the reflected appraisals. This creates a –10 to +10 scale. A higher value on the discrepancy measure means that others see the students more positively than how the students see themselves as a science student.

3.2.3. Other independent measures

3.2.3.1. *Grade point average*. Cumulative grade point average (GPA) is an objective measure of successful performance of the science student identity. The student's current cumulative GPA is included in waves 4, 6, and 8. GPA is self-reported by the student on a conventional 0–4.0 scale.

3.2.3.2. *Science self-efficacy*. Participants indicate the extent to which they can successfully complete a series of tasks such as “Generate a research question to answer,” “Develop theories (integrate and coordinate results from multiple studies),” and “Report research results in a written paper.” Responses range from “Not at all Confident” to “Absolutely Confident” (Coded 1–5). As shown in Table 1, the items form a single scale with an omega reliability of 0.97. We average the items with a higher score representing a higher science self-efficacy.

3.2.4. Performance goals

3.2.4.1. *Performance approach orientation*. On the performance-approach goal orientation scale, students indicate the degree to which they agree with six statements having to do with their motivation to compete against and demonstrate abilities

Table 1
Omega reliabilities and principle components factor analysis for scales.

	Factor Score
Identity Prominence	
In general, being a scientist is an important part of my self-image.	0.89
I have a strong sense of belonging to the community of scientists.	0.84
Being a scientist is an important reflection of who I am.	0.89
I have come to think of myself as a 'scientist.'	0.87
	$\Omega = 0.92$
Reflected Appraisals	
How do you think that your family members rate you as a student?	0.84
How do you think your coworkers rate you as a student?	0.85
How do you think your friends rate you as a student?	0.90
How do you think your partner/spouse rates you as a student?	0.84
	$\Omega = 0.89$
Science Self-Efficacy – I am confident that I can ...	
Use technical science skills (use of tools, instruments, and/or techniques).	0.74
Use scientific language and terminology.	0.77
Generate a research question to answer.	0.79
Figure out what data/observations to collect and how to collect them.	0.81
Figure out/analyze what data/observations mean.	0.81
Create explanations for the results of the study.	0.82
Use scientific literature and/or reports to guide research.	0.79
Relate results and explanations to the work of others.	0.82
Develop theories (integrate and coordinate results from multiple studies).	0.79
Report research results in an oral presentation.	0.69
Report research results in a written paper.	0.74
Understand the ethics of research.	0.72
Generally function as a scientist in a research activity.	0.83
Learn the full range of science skills with appropriate training.	0.69
	$\Omega = 0.97$
Performance Approach Orientation	
I would feel really good if I were the only one who could answer the teachers' question in class.	0.78
It's important to me that the other students in my classes think that I am good at my work.	0.73
I want to do better than other students in my classes.	0.83
I would feel successful in school if I did better than most of the other students.	0.85
I would like to show my teachers that I'm smarter than the other students in my classes.	0.86
Doing better than other students in school is important to me.	0.87
	$\Omega = 0.92$
Performance Avoidance Orientation	
It's very important to me that I don't look stupid in my classes.	0.80
An important reason I do my school work is so that I don't embarrass myself.	0.85
The reason I do my school work is so my teachers don't think I know less than others.	0.87
The reason I do my school work is so others won't think I'm dumb.	0.85
One reason I would not participate in class is to avoid looking stupid.	0.69
One of my main goals is to avoid looking like I can't do my work.	0.80
	$\Omega = 0.92$
Science Behavior – In the past six months have you ...	
Personally designed or conducted an original research project?	0.69
Designed or conducted an original research project as part of a research team?	0.71
Submitted a paper for publication on which you were listed as an author?	0.71
Been an author on a paper that was accepted for publication?	0.65
Presented original research at an academic research fair or competition?	0.65
	$\Omega = 0.79$

relative to their peers (Hernandez et al., 2013; Midgley et al., 1998). Statements include, for example, “I want to do better than other students in my classes” and “I would like to show my teachers that I'm smarter than the other students in my classes.” Responses categories range from “Strongly Disagree” to “Strongly Agree” (Coded 1–5). Table 1 reveals that the items form a single scale with an omega reliability of 0.93. The items are averaged with a higher score representing a higher performance approach orientation.

3.2.4.2. *Performance avoidance orientation.* For the performance-avoidance goal orientation scale, students report the degree to which they agree with six statements having to do with their motivation to avoid demonstrating a lack of abilities and skills relative to their peers (Hernandez et al., 2013; Midgley et al., 1998). Statements include, for example, “It's very important to me that I don't look stupid in my classes,” and “The reason I do my school work is so others won't think I'm dumb.” Responses

categories range from “Strongly Disagree” to “Strongly Agree” (Coded 1–5). Table 1 shows that these items form a single scale with an omega reliability of 0.92. The items are averaged with a higher score representing a higher performance avoidance orientation.²

3.2.4.2.1. *Intention.* Participants identify the extent to which they intend to pursue a science-related research career. Response categories range from “Definitely will not” to “Definitely will” (Coded 0–10). A higher score reflects a higher intention to pursue a science-related career.

3.2.4.2.2. *Science behavior.* Five indicator variables assess the participant's science behavior. Participants indicate whether they have engaged in any of the following activities (coded 0/1) during the past six months: “Personally designed or conducted an original research project?”; “Designed or conducted an original research project as part of a research team?”; “Submitted a paper for publication on which you were listed as an author?”; “Been an author on a paper that was accepted for publication?” and “Presented original research at an academic research fair or competition?” We see in Table 1 that the items form a single scale with an omega reliability of 0.79. We average the items, and a higher score reflects engagement in more science activities.

3.2.4.2.3. *Mentoring.* Three indicator variables assess the mentoring construct. Participants indicate the extent to which their mentor provides each of the following opportunities: “Helps you finish assignments/tasks or meet deadlines that otherwise would have been difficult to complete?”; “Helps you improve your writing skills?” and “Explores career options with you?” Response categories are “Not at all” to “To a very large extent” (Coded 1–5). The correlation among these items is high (finish assignments and improve writing $r = 0.57$; finish assignments and explore career options $r = 0.41$; and improve writing and explore career options $r = 0.44$). The items were averaged with an omega reliability of .74. A higher score represents a higher frequency of mentoring.

3.2.4.2.4. *Background characteristics.* Background factors include parents' educational attainment (at least one parent with college degree = 1), race/ethnicity (coded as three dummy variables: African American/Black, Latino/a, and other race/reference category), and gender (male = 1).

3.3. Analysis

We use structural equation modeling to estimate the general linear model being proposed because it affords us the opportunity to use the best approach to analyzing data with missing data. Because about 18% of the data for this study is missing, scattered across the variables of interest, OLS regression using listwise deletion of data leaves only 214 cases with complete data for analysis, thus discarding a great deal of data and yielding potentially biased results. Instead, we estimate the model using full information maximum likelihood (FIML) procedures that allow us to estimate the coefficients using all possible data. Maximum likelihood (ML) estimates are more efficient than multiple imputations (MI), and for the same dataset, ML always gives the same results, while MI gives different results for each run. MI also requires a number of uncertain decisions such as how many datasets are enough, how many iterations per dataset, which variables should be used to impute missing values, as well as a number of other decisions (Allison, 2009, 2012). FIML avoids dropping cases with partial data or imputing data to missing values, which alternative procedures are biased or less efficient (Enders and Bandalos, 2001). Participants are in the analysis if they are present for waves 6, 8, and 10. Maximum likelihood missing values procedures estimate the structural and measurement models so that all observed data for the 966 cases are used.

Our model predicts being employed in a science related occupation at wave 10 from the identity and other measures in wave 8 (a year earlier). We then use wave 6 with the same measures to examine what influences the important predictors of occupation, and we use the wave 4 measures to predict wave 6 thus taking our understanding another step further back. For this analysis, we constrain theoretically equivalent coefficients at different time points to be equal. For example, the effect of the science identity in wave 4 on the prominence of the science identity in wave 6 is constrained to be equal to the effect of the science identity in wave 6 on identity prominence in wave 8. Because second-order autocorrelations across time have frequently been found to be important (Burke and Cast, 1997), these are included for the science identity variables, science efficacy, intentions, and science behavior.³ We evaluate model fit using the RMSEA coefficient (Browne and Cudeck, 1993).

4. Results

The means and standard deviations of all of the measures across the waves are in Table 2. We find that 46% of the current students have at least one parent who has a college degree. National data reveals that for recent bachelor graduates in STEM, almost 44% have at least one parent who has a college degree (National Science Foundation, 2016). When we examine bachelor graduates across our five waves of data, 46% have at least one parent with a bachelor's degree. Thus our sample is similar to what we find among STEM students. Other sample characteristics include a student population that is 45% Black, 42% Latino/a, 26% male, and 74% female.

² Perhaps counterintuitively at first glance, performance approach and avoidance orientations are typically positively and significantly correlated (Linnenbrink-Garcia et al., 2012). Having a performance approach orientation is focused primarily on appearing smart and successful. Having a performance avoidance orientation is focused primarily on avoiding appearing stupid and like a failure.

³ The code for the full model that we estimate is available upon request.

Table 2
Means and standard deviations of variables (N = 966).

	Wave 4		Wave 6		Wave 8		Wave 10	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Science occupation	—	—	—	—	0.27	0.44	0.29	0.45
Science identity	7.56	1.76	7.59	1.74	7.67	1.66	—	—
Identity prominence	3.64	1.02	3.64	1.12	3.58	1.06	—	—
Identity discrepancy	1.09	1.42	1.07	1.24	0.99	1.24	—	—
GPA	3.34	0.45	3.37	0.49	3.49	0.49	—	—
Science self-efficacy	4.07	0.65	4.13	0.66	4.12	0.68	—	—
Performance approach	3.34	1.08	3.32	1.09	3.30	1.06	—	—
Performance avoidance	2.59	1.13	2.55	1.14	2.58	1.15	—	—
Intention	7.45	2.78	7.06	2.97	6.80	3.06	—	—
Science behavior	0.23	0.27	0.21	0.28	0.18	0.26	—	—
Mentoring	3.52	0.92	3.42	0.98	3.40	0.99	—	—
Parent education	0.46	0.50	0.46	0.50	0.46	0.50	—	—
Black	0.45	0.50	0.45	0.50	0.45	0.50	—	—
Latino	0.42	0.49	0.42	0.49	0.42	0.49	—	—
Male	0.26	0.44	0.26	0.44	0.26	0.44	—	—

By wave 10, only 29% of the students are in a science-related occupation. This is likely to be the first job for many but not all students who initially are followed since some may still be in school.⁴ We do find that students report a relatively high science identity (Mean = 7.56) and a prominent science identity (Mean = 3.64). Students do not experience a lot of discrepancy in their science identity (Mean = 1.09). Generally, they think that their friends, family members, partners, and coworkers see them as a science student in the same way that they see themselves as a science student. If a discrepancy occurs, the tendency is for others to rate students more positively as a science student than how students rate themselves.

Students are fairly confident that they can successfully complete a series of tasks that are science related (Mean = 4.07). They also are more likely to endorse a performance approach strategy (Mean = 3.34) than a performance avoidance strategy (Mean = 2.59) as they compare their skills and abilities to their peers. Students rate fairly high on their intention to pursue a science career (Mean = 7.45). Only about 25% of them report being engaged in science activities such as designing and carrying out original research (Mean = 0.23), but they indicate a higher than average frequency of their mentor providing instrumental help (Mean = 3.52).

Table 3 shows the correlations among the variables. High correlations emerge between the science identity and identity discrepancy ($r = -0.62, p \leq 0.05$) and between GPA and successful performance of the science identity ($r = 0.38, p \leq 0.05$). Significant correlations also emerge between the identity concepts and those related to alternative theories such as self-efficacy and mentoring with the relationship relatively high between science self-efficacy and the science identity ($r = 0.32, p \leq 0.05$) and identity prominence ($r = 0.44, p \leq 0.05$), although less so between mentoring and the science identity ($r = 0.25, p \leq 0.05$) and identity prominence ($r = 0.23, p \leq 0.05$). Significantly associated with our outcome, science occupation, is a higher science identity ($r = 0.10, p \leq 0.05$) and higher science self-efficacy ($r = 0.09, p \leq 0.05$). At issue is whether these factors still influence the science occupation when controlling for other relevant factors. These results are presented in Tables 4 and 5.

Table 4 shows the standardized results for the basic structural equation models. In Model 1, we estimate the effects of the identity variables for the science occupation without controlling for other factors. We find that having a science occupation in wave 8 is positively associated with reports of a science occupation in wave 10 ($\beta = 0.55, p \leq 0.05$), showing a continuity of employment. Further, one's science identity in wave 8 positively influences entering a science occupation in wave 10 ($\beta = 0.11, p \leq 0.05$).

In Model 2, we see that none of the other control factors predict entering a science occupation. Using the structural equations test for invariance, both of these models are invariant across sex ($X^2_{(14)} = 12.5, p = ns$), across ethnic groups, ($X^2_{(26)} = 32.0, p = ns$), and across three groups of STEM fields ($X^2_{(28)} = 16.4, p = ns$), thus the results are robust.⁵ The finding supports Hypothesis 1, but not Hypotheses 2 or 3 where we expected identity prominence and identity discrepancy to influence entering a science occupation. Since the science identity is the only factor of significance and appears to mediate any other effects, we examine the factors associated with the science identity at an earlier point in time. These results are in Table 5 and serve as Model 3.

In the bottom portion of Table 5, the results show the factors in wave 6 that significantly influence the science identity in wave 8. The top portion of the table reveals the factors in wave 4 that significantly influence the factors in wave 6 that, in turn, lead to the science identity in wave 8. In the Appendix, we provide all of the effects for all of the variables, both identity

⁴ We know that at wave 10, 10% are still undergraduates, 32% are in graduate school, 29% are employed in science occupations, and 29% are not in science occupations or are not employed.

⁵ We also test the effect of omitting participants who were graduate students at the start, and participants who are still students at wave 10. These models are nearly identical to those presented in Table 4 and are available upon request.

Table 3
Correlations among the variables, wave 8 ($N = 966$).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1 Science occupation	1														
2 Science identity	0.10	1													
3 Identity prominence	0.06	0.21	1												
4 Identity discrepancy	-0.01	-0.62	-0.06	1											
5 GPA	0.07	0.38	0.13	-0.17	1										
6 Science self-efficacy	0.09	0.32	0.44	-0.09	0.18	1									
7 Performance approach	-0.02	0.06	0.11	-0.01	0.06	0.03	1								
8 Performance avoidance	-0.06	-0.19	-0.04	0.05	-0.11	-0.12	0.39	1							
9 Intention	0.06	0.19	0.56	-0.05	0.26	0.21	-0.11	-0.07	1						
10 Science behavior	0.02	0.14	0.29	-0.12	0.21	0.14	-0.07	-0.01	0.36	1					
11 Mentoring	0.03	0.25	0.23	-0.15	0.08	0.37	-0.02	-0.02	0.13	0.10	1				
12 Parent Education	0.03	0.03	0.03	-0.01	-0.03	0.08	0.02	0.02	-0.05	0.04	-0.11	1			
13 Black	-0.04	-0.02	-0.11	-0.02	-0.13	-0.03	-0.04	0.05	-0.05	-0.06	0.01	0.07	1		
14 Latino	0.03	0.06	0.14	0.04	0.07	0.07	0.03	-0.07	0.08	0.02	-0.05	-0.09	-0.76	1	
15 Male	-0.01	0.04	0.17	-0.04	0.04	0.05	0.00	-0.09	0.03	0.06	-0.03	-0.01	-0.19	0.10	1

Bolded correlations = $p \leq 0.05$.

Table 4
Standardized estimates for science occupation in wave 10 ($N = 966$).

Wave 8	Science occupation	
	Model 1	Model 2
Science occupation	0.55*	0.55*
Science identity	0.11*	0.10*
Identity prominence	0.03	0.04
Identity discrepancy	0.06	0.05
GPA	0.03	0.04
Science self-efficacy		0.00
Performance approach		0.03
Performance avoidance		-0.01
Intention		0.00
Science behavior		0.01
Mentoring		-0.02
Parent education		0.05
Black		-0.02
Latino		0.00
Male		0.00
R ²	0.33	0.34

RMSEA = 0.00 for Model 1 and for Model 2; * $p \leq 0.05$.

constructs and those related to alternative theories, in wave 6 and wave 8. Overall, in Table 5, the model fits the data well (RMSEA = 0.03). In the bottom of Table 5, we see that the science identity has a moderately strong stability coefficient from wave 6 to wave 8 ($\beta = 0.41$, $p \leq 0.05$). This stability coefficient is even stronger from wave 4 to wave 6 ($\beta = 0.62$, $p \leq 0.05$) as shown in the final column in the top part of Table 5. Four other factors are associated with a science identity, which in turn, are related to entering a science occupation.

The strongest other factor associated with a science identity is GPA, an objective measure of students' performance in the science identity. Higher cumulative GPA in wave 6 is related to a higher science identity in wave 8 ($\beta = 0.13$, $p \leq 0.05$). The relationship also occurs at an earlier point in time, from wave 4 to wave 6 ($\beta = 0.07$, $p \leq 0.05$) when higher science identity is also related to higher GPA in wave 6 ($\beta = 0.25$, $p \leq 0.05$). Other factors that associated with cumulative GPA include GPA at an earlier wave ($\beta = 0.59$, $p \leq 0.05$), as well as identity prominence (although this association is unexpectedly negative) ($\beta = -0.06$, $p \leq 0.05$), a positive identity discrepancy (others see participants as better students than how they see themselves) ($\beta = 0.09$, $p \leq 0.05$), a performance avoidance orientation (efforts to avoid the appearance of incompetence) ($\beta = -0.06$, $p \leq 0.05$), and engaging in science activities such as designing and conducting original research ($\beta = 0.09$, $p \leq 0.05$).

Four other variables have relatively small, but still significant effects on the science identity. First, the prominence of the science student identity in wave 6 unexpectedly is negatively related to the science identity in wave 8 ($\beta = -0.02$, $p \leq 0.05$); this pattern occurs in the earlier time point, from wave 4 to wave 6. Curiously, a larger and positive relationship emerges between the science identity in wave 4 predicting identity prominence in wave 6 ($\beta = 0.15$, $p \leq 0.05$). This is more consistent with our expected association between these two identity constructs. Moreover, intention to pursue a research career in wave 4 is also related to an increase in identity prominence in wave 6 ($\beta = 0.16$, $p \leq 0.05$).

Table 5
Standardized estimates of background effects to wave 8 (model 3) (N = 966).

Source	Outcomes					
	Wave 6					
Wave 4	Science behavior	Performance avoidance	GPA	Identity discrepancy	Identity prominence	Science identity
Science identity	-0.08	-0.12*	0.25*	-	0.15*	0.62*
Identity prominence	0.03	0.04	-0.06*	0.02	0.48*	-0.02*
Identity discrepancy	-0.12*	-0.02	0.09*	0.45*	0.01	0.03*
GPA	0.16*	0.02	0.59*	0.05	0.01	0.07*
Science self-efficacy	-0.01	-0.03	-0.03	0.07	0.02	0.00
Performance approach	0.02	0.08*	0.03	-0.02	0.02	0.01
Performance avoidance	-0.03	0.46*	-0.06*	0.09*	0.07*	-0.02*
Intention	0.14*	-0.03	0.01	-0.01	0.16*	0.00
Science behavior	0.38*	0.00	0.09*	-0.04	-0.01	0.03*
Mentoring	0.01	0.02	0.01	-0.01	0.04	0.03
R ²	0.36	0.37	0.48	0.33	0.61	0.44
Wave 8						
Wave 6						Science identity
Science identity	-	-	-	-	-	0.41*
Identity prominence	-	-	-	-	-	-0.02*
Identity discrepancy	-	-	-	-	-	0.03*
GPA	-	-	-	-	-	0.13*
Science self-efficacy	-	-	-	-	-	0.04
Performance approach	-	-	-	-	-	0.01
Performance avoidance	-	-	-	-	-	-0.02*
Intention	-	-	-	-	-	0.00
Science Behavior	-	-	-	-	-	0.03*
Mentoring	-	-	-	-	-	0.07
R ²	-	-	-	-	-	0.42

RMSEA = 0.03; *p ≤ 0.05

Second, those who experience a positive discrepancy in the science identity, that is, they think that others evaluate them as better science students than how they see themselves, in wave 6 report a slightly higher science identity in wave 8 ($\beta = 0.03, p \leq 0.05$). This relationship also occurs from wave 4 to wave 6 as shown in the top half of Table 5 ($\beta = 0.03, p \leq 0.05$). At issue, then, is what predicts experiencing a science identity discrepancy? While a discrepancy in the science identity from a previous wave plays a significant role ($\beta = 0.45, p \leq 0.05$), we also find that in wave 4, those who are motivated to avoid the appearance of incompetence ($\beta = 0.09, p \leq 0.05$) report a science identity discrepancy in a positive direction in wave 6. Thus, seeking to avoid performances that might make them look ignorant influences people's perception that others see them as better science students than how they see themselves. More generally, experiencing a positive discrepancy in the science identity is associated with an increase in science students' views of themselves over time, which in turn, influences them entering a science occupation. Here we see the impact of reflected appraisals in changing one's science identity.

Third, engaging in science activities, such as designing and conducting original research, in wave 6 is related to higher science identity in wave 8 ($\beta = 0.03, p \leq 0.05$). The same relationship exists from wave 4 to wave 6. Apparently, for the few who get involved in research (about 25% of the students), participating in original research helps to encourage a science identity. Engagement in science activities in wave 4 also is associated with a higher GPA ($\beta = 0.09, p \leq 0.05$) in wave 6.

Finally, performance avoidance orientation also influences one's science identity in wave 8. In wave 6, those who indicate that they are motivated to avoid looking ignorant report a lower science identity in Wave 8 ($\beta = -0.02, p \leq 0.05$). This also appears from wave 4 to wave 6. Further, in wave 4, a higher science identity is related, as shown in row 1, to a lower performance avoidance orientation in wave 6 ($\beta = -0.12, p \leq 0.05$). Performance avoidance at an earlier point in time (wave 4) is related to its use in wave 6 ($\beta = 0.46, p \leq 0.05$).

Overall, while a higher science identity directly influences entering a science occupation, other factors are associated with a higher science identity, and thus appear to indirectly influence choosing a science occupation. How students think that others see them as a science student influences their own evaluation of themselves as a science student with others more positive assessment of them as a scientist producing a higher science identity, and in turn, a science-related job. Cumulative GPA, as an objective assessment of performance of the science identity, and engaging in science activities also are related to higher science identity and subsequent entrance into a science-related job. Finally, the reduced motivation to perform well in school to avoid looking ignorant increases the science identity and, in turn, entering a science occupation.

5. Discussion

Recent data provide a sobering view of STEM education in the United States. Evidence from the Program for International Student Assessment ranks the U.S. in the bottom half of comparable countries. The U.S. ranks number 20 of the 34 Organization for Economic Cooperation and Development (OECD) countries in science education and near the bottom (27 of 34) in math education ([Organization for Economic Co-operation and Development, 2012](#)). Moreover, women and minorities remain underrepresented in most STEM disciplines and occupations ([National Science Foundation, 2015](#)).

Strategies designed to boost participation in STEM educational programs such as teacher initiative programs and college minority programs may help reduce the shortage of women and minorities. However, what has been omitted from these strategies is, first, an analysis and understanding of the extent to which these students take on and embrace a science identity, and second, given this identity, whether these students actually end up taking on a science occupation upon leaving school. Analysts need to capture one's identity and the corresponding dimensions of the identity process during the school years. In understanding and promoting STEM achievement, we need to be more attentive to individuals' self-views because the degree to which individuals claim the science identity will have a direct bearing on their movement into science occupations.

In this research, we have done that. We looked at actually entering a science occupation and the role that several factors including having a strong science identity have played in that decision for minority students. Our primary result was that only the science identity itself, among all the factors considered, influences moving into a science occupation upon graduation. Identities importantly move people into compatible positions in the social structure ([Burke and Stets, 2009](#)). We see this principle operating in the present research: persons from underrepresented groups with strong science identities are more likely to actually move into a science occupation following their graduation. Thus, given a growing body of evidence that reveals the impact of the science identity on involvement in science careers, it would be beneficial to more fully develop the science identity of those currently in STEM programs.

The current research shows one main factor that influences the science identity. Evidence suggests students change their science identity in the direction of their GPA, which is an objective measure of success in the science identity. The more successful are students' school performance as measured by their GPA, the more it will raise their evaluation of being good scientists, which will lead to choosing jobs in science-related fields. This finding is consistent with the evidence showing a small but significant effect of identity discrepancy on the science identity. Students change their science identity in the direction of others' views given that when they think others judge them more positively than how they view themselves, they are more likely to develop a strong science identity. This is a reflected appraisals process whereby persons change their identity to be more in line with how they are seen by significant others ([Burke and Stets, 2009](#)).

Aside from one's identity of being a scientist, other processes indirectly influence entering a science occupation through the science identity. Reducing the performance avoidance orientation (the focus on avoiding the appearance of incompetence) may help lead students to a stronger science identity and to enter a science career. If reducing a focus on avoiding the appearance of incompetence increases the science identity, our findings also reveal that an increase in the science identity reduces the focus on avoiding the appearance of incompetence. Thus, the relationship between a performance approach orientation and the science identity is reciprocal. Finally, engaging in science activities such as participating in original research also strengthens the science identity.

We remind the reader that there are other factors that likely influence the decision to enter a science-related occupation. For example, while minority students may experience discrimination in the hiring process that prevents them from obtaining a science job, this appears not to be the case in our sample since race had no impact on entering a science occupation. Alternatively, individuals may not live in an area where science jobs are available. Still other constraints that are beyond their control may prevent job opportunities for them in science, for example, caring for kin and extended kin that may make a full-time job difficult to enter. Future research needs to examine how much these constraints close doors for minority people.

In sum, our research shows that among all the factors considered, the identity process is the primary mechanism through which minority students choose a science occupation. Where other theoretical processes, like goal theory, self-efficacy theory, and attitude theory have effects, they operate through the identity process. The findings reveal the importance of the identity process in understanding involvement in science not only in school but also in transitioning into the labor market. Thus we see how an identity formulated in one institution – the educational system – has effects that persist to another institution – the economy. If the goal is to increase the participation of the young and minorities in STEM, we need to more closely study the identity process during the school years. It appears to be important in understanding a critical social problem of getting more individuals involved in science so that the United States can be more competitive globally.

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Appendix

Standardized Effects from Wave 6 to Wave 8 (N = 966)										
Source	Outcomes ¹									
	Wave 8									
Wave 6	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1 Science identity	0.41*	0.01	—	0.13*	−0.02	0.01	−0.11*	−0.03	0.05	0.33*
2 Identity prominence	−0.02*	0.51*	0.12*	−0.07*	0.12	0.03	−0.01	0.10*	0.03	−0.01
3 Identity discrepancy	0.02*	0.01	0.41*	0.09*	−0.02	−0.01	−0.02	0.00	−0.02	0.12*
4 GPA	0.13*	0.02	−0.06	0.62*	−0.01	0.03	0.05	0.10*	0.05	−0.24*
5 Science Self-efficacy	0.04	0.11*	−0.09*	0.03	0.46*	−0.03	−0.03	0.04*	−0.01	−0.04
6 Performance approach	0.01	0.02	−0.02	0.03	−0.05	0.56*	0.08*	−0.02	−0.05	−0.04
7 Performance avoidance	−0.02*	0.07*	−0.05	−0.06*	0.00	0.03	0.38*	0.05	0.01	0.08*
8 Intention	0.00	0.18*	−0.01	0.01	0.07*	0.04	−0.04	0.42*	0.15*	0.09*
9 Science behavior	0.03*	0.08*	−0.04	0.10*	0.05*	−0.06*	0.00	0.08*	0.40*	0.02*
10 Mentoring	0.07	−0.02	−0.13*	0.02	0.00	−0.05	−0.01	0.03	0.01	0.31
R ²	0.44	0.62	0.33	0.48	0.46	0.56	0.37	0.47	0.36	0.33

Standardized Effects from Wave 4 to Wave 6 (N = 966)										
Wave 4	Wave 6									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1 Science identity	0.62*	0.15*	—	0.25*	0.21*	0.01	−0.12*	−0.03	−0.08	0.34*
2 Identity prominence	−0.02*	0.48*	0.02	−0.06*	0.02	0.03	0.04	0.21*	0.03	−0.02
3 Identity discrepancy	0.03*	0.01	0.45*	0.09*	0.12*	0.02	−0.02	−0.05	−0.12*	0.14*
4 GPA	0.07*	0.01	0.05	0.59*	−0.03	0.01	0.02	0.03	0.16*	−0.05
5 Science self-efficacy	0.00	0.02	0.07	−0.03	0.51*	−0.03	−0.03	0.04*	−0.01	−0.07
6 Performance approach	0.01	0.02	−0.02	0.03	0.01	0.60*	0.08*	−0.03	0.02	−0.04
7 Performance avoidance	−0.02*	0.07*	0.09*	−0.06*	−0.01	0.03	0.46*	0.00	−0.03	0.09*
8 Intention	0.00	0.16*	−0.01	0.01	0.07*	0.04	−0.03	0.41*	0.14*	0.08
9 Science behavior	0.03*	−0.01	−0.04	0.09*	0.05*	−0.06*	0.00	0.09*	0.38*	0.02*
10 Mentoring	0.03	0.04	−0.01	0.01	0.00	0.02	0.02	0.03	0.01	0.35*
R ²	0.42	0.40	0.22	0.52	0.40	0.38	0.28	0.36	0.27	0.23

¹ Wave 4 to 6 effects were constrained to be equal to wave 6 to 8 effects unless they tested to be significantly different ($\chi^2_{(49)} = 54.22, p = 0.28$). RMSEA = 0.03; * $p \leq 0.05$.

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