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Exploring Correlations Among STEM Identities and Personal Identities of Undergraduate Students in Idaho Public Post-Secondary Institutions

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Abstract

Inequities in STEM persist, notably in underrepresented groups relating to gender, race, socio-economic status, and disability. The purpose of this study was to explore correlations between STEM identities and personal identities of undergraduate students in Idaho public post-secondary institutions. This study was guided by Gee's (2001) identity theory and Carlone and Johnson's (2007) STEM-ID model. These theories emphasized the critical roles that identity, experience, and perception play in student success. The survey was administered statewide in the first half of the Fall 2024 term. Participants from College of Eastern Idaho, College of Southern Idaho, North Idaho College, and University of Idaho (n = 579) completed the survey. Quantitative data analysis indicated that, overall, undergraduate students at Idaho postsecondary institutions had slightly positive STEM identities, with areas ranked high to low: performance and competence (M = 3.95, SD = .79), belonging (M = 3.74, SD = 0.95), recognition (M = 3.67, SD = .91), and interest (M = 3.65, SD = 1.07). Data also indicated that there were significant differences in STEM identities for all academic and personal demographics explored. Further research should be conducted to explore these correlations.
Keywords: career and technical education, higher education, rural students, STEM identity, student success, STEM education

Introduction

For successful STEM education, all students, regardless of personal identity, must experience equitable access to opportunities and success. While many diverse students, especially those who take Career and Technical Education (CTE) courses in secondary school, continue to pursue STEM-related careers after high school (HS) graduation, they do not pursue them at projected rates (ACTE, 2022). The reasons for this phenomenon are unknown.

The U.S. Commission on National Security/21st Century (2001) noted the importance of developing a diverse and competitive STEM workforce in the United States:

> Second only to a weapon of mass destruction detonating in an American city, we can think of nothing more dangerous than a failure to manage properly science, technology, and education for the common good over the next quarter century. (p. 30)

Nearly a quarter century after this statement, we are witnessing the repercussions of the United States' failure to properly manage STEM education. The current lack of diverse representation in STEM-related fields has contributed to the U.S. having a decline in global citizenship and continued restrictions on equitable social mobility (Fry et al., 2021).

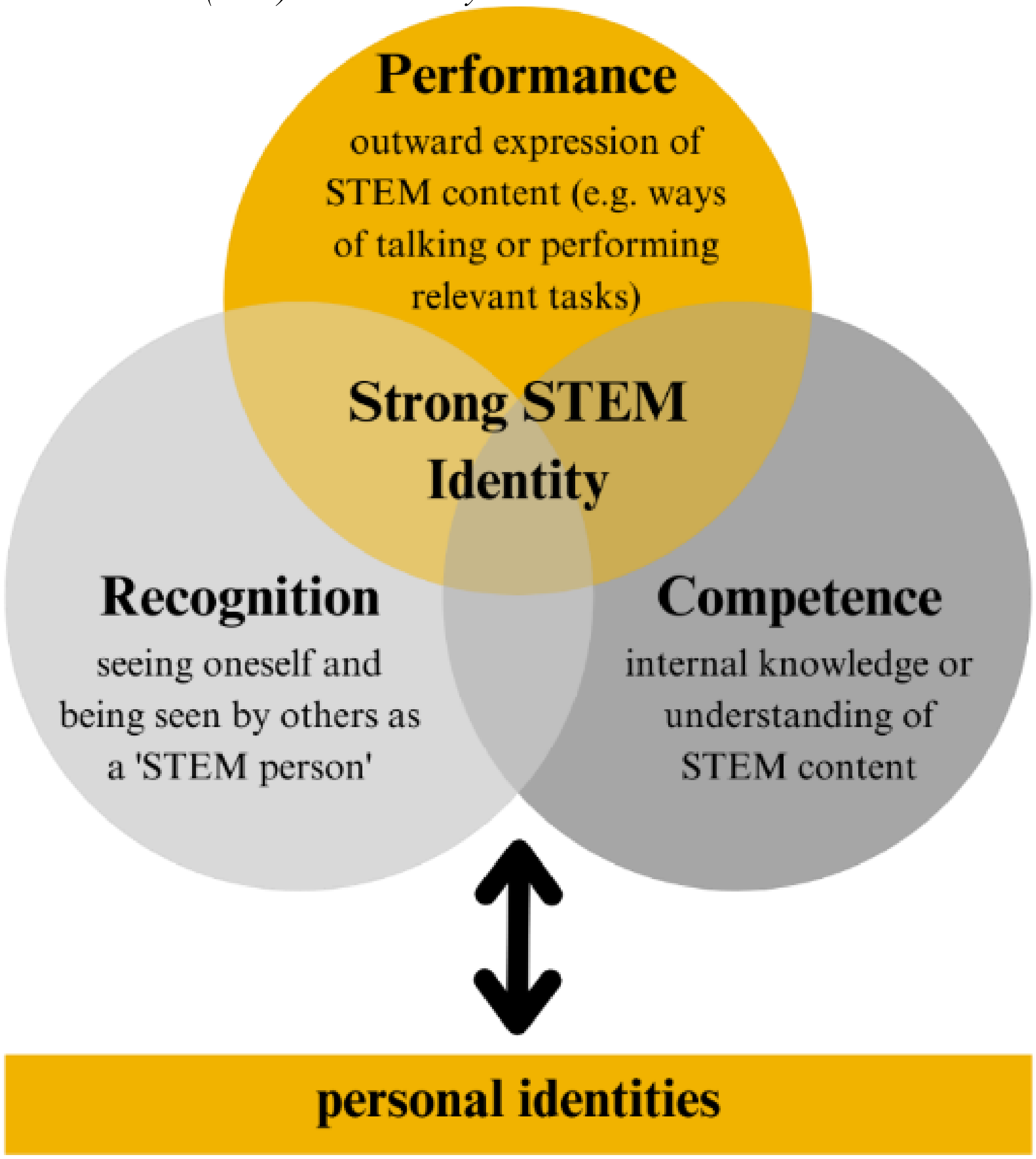
Though advances have been made in diversity and representation in STEM-related fields, the participation of underrepresented gender and racial groups, low-income populations, and people with disabilities within STEM-related fields remains disproportionately low (CEOSE, 2020; National Research Council, 2009). Significant differences in STEM subject scores also exist among students by gender, race, socio-economic status (SES), and disability (CEOSE, 2020; Hallinen, 2021; NAEP, 2019). On average, individuals who complete a bachelor's degree will earn over one million dollars more in their lifetime than those who have a HS diploma (Carnevale et al., 2011). While the number of individuals earning a bachelor's degree or higher has doubled since 1972, attainment of these degrees varies significantly by gender, race, SES, and disability (Reber & Smith, 2023). Exploration of identities, including STEM identities and lived experiences, can contribute to a better understanding of students' persistence in STEM education and careers. Considering the above, more research is needed to understand the lack of diversity in STEM-related education and careers. One place to capture such information would be undergraduate students at public post-secondary institutions. Information from this population may provide insight into correlations between STEM and personal identities.

Theoretical Framework

This study was guided by Gee's (2001) identity theory and Carlone and Johnson's (2007) STEM-ID model. Gee (2001) defined identity as what it means to be a 'certain kind of person.' Identities are intersectional, tied to historical, institutional, and sociocultural forces. Gee described four ways to view identity: *nature*, *institution*, *discourse*, and *affinity* identity. Historically, Western society moved from nature identity ("we are what we are primarily because of our 'natures'"), to institution identity ("we are what we are primarily because of the positions we occupy in society"), to discourse identity ("we are what we are primarily because of our individual accomplishments as they are interactionally recognized by others"), to affinity identity ("we are what we are because of the experiences we have had within certain sorts of 'affinity groups'"). In the United States, all four views have coexisted in theory and in practice. Each view exists as a strand that intertwines with each other, dependent upon the context of specific places, times, and experiences.

These four identities should be considered in the definition and exploration of STEM identity. Individuals can have a strong or weak STEM identity. A strong STEM identity indicates that an individual would exhibit a sense of affiliation, built by intrinsic and extrinsic factors, to the STEM community (Bernard, 2020). Individuals with strong STEM identities are more likely to engage with learning, persist through barriers, and pursue careers in STEM (Chen & Wei, 2022; Gonsalves et al., 2021; Schon, 2015; Shattuck & Cheney, 2020). Many barriers exist to attain a strong STEM identity though. Underrepresented and minority groups have been less likely to develop a strong STEM identity, indicating that there may be correlations between personal and STEM identities (National Research Council, 2009). Carlone and Johnson (2007) developed a model to illustrate STEM identity development (see Figure 1).

Figure 1
Carlone and Johnson (2007) STEM Identity Model



In their model, STEM identity was broken down into three dimensions: *competence*, *performance*, and *recognition*. Competence is the internal knowledge or understanding of STEM content. Performance is the outward expression of STEM content. Recognition is seeing oneself and being seen by others as a ‘STEM person.’ If an individual has a strong STEM identity, they would be more likely to rate themselves highly and be rated highly by others in each of the three dimensions. An additional part of this model was that individuals’ personal identities affected STEM identity development (Carlone & Johnson, 2007; Liu et al., 2023).

Purpose and Research Questions

The purpose of this study was to explore correlations between STEM identities and personal identities of undergraduate students in Idaho public post-secondary institutions. The following research questions guided this study:

1) What are the STEM identities of undergraduate students at public State postsecondary institutions? and
2) What are the differences by reported demographic/academic variables of undergraduate students' STEM identities at public State post-secondary institutions?

Review of Pertinent Literature

STEM Education

Successful STEM education is crucial for an informed population capable of citizenship and an avenue of social mobility for a diverse population (Committee for Economic Development, 2003; Koehler et al., 2021; UNESCO, 2016).

Citizenship

Beyond the economical need for student success in STEM, students must develop successfully in STEM-related knowledge to prevent a weakness in basic science and math skills. Weaknesses in these basic skills could result in a decline in global citizenship (Committee for Economic Development, 2003; Cosgrove, 2008; Nguyen, 2023; OECD, 2018). *Global citizenship* is the social, political, environmental, and economic actions of individuals and communities who act as members of multiple, diverse, local and non-local communities, instead of singletons in isolated societies (United Nations, 2023). The practice of global citizenship leads to global competence. Individuals who are globally competent "examine local, global and intercultural issues, understand and appreciate different perspectives and world views, interact successfully and respectfully with others, and take responsible action toward sustainability and collective well-being" (OECD, 2018).

Humanity has never recorded such access to information and data as they presently do. Competency in STEM-related knowledge is necessary for humans to successfully navigate this information and data with the mindset of global citizenship. Without scientific and mathematical literacy, information and data can be misunderstood. This may negatively impact national and global citizenship, with the potential to influence social, economic, political, and environmental crises (Committee for Economic Development, 2003; Cosgrove, 2008; Edwards, et al., 2020; Nguyen, 2023). The United Nations recognized the need for global citizenship (Nguyen, 2023; OECD, 2018; UNESCO, 2016). One of the 2015 UN Sustainable Development Goals for 2030 was to,

> ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promoting of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and culture's contribution to sustainable development. (UNESCO, 2016, p. 48)

Part of citizenship is creating educational and career spaces that are safe and accessible for a diverse population. In building global citizenship through STEM education, the U.S. must build a future workforce that promotes access and protect diverse employees in STEM-related fields.

Social Mobility for a Diverse Population

Diversity in STEM-related fields is also crucial for economic and social success, both nationally and globally. In the post-Sputnik technology rush, many of the recruited students were first-generation college students (Committee for Economic Development, 2003). As a result, these first-generation students experienced a previously unattainable advancement in economic betterment and social mobility. This advancement opportunity still exists for those entering STEM-related fields, especially those from diverse backgrounds. Due to this, many underrepresented populations have entered STEM education to improve their social and economic standing (Committee for Economic Development, 2003; Nguyen, 2023). With the U.S. population more diverse than ever reported, especially in citizens under 18 years of age, STEM-related fields are projected to need appeal to a more diverse population of workers (Johnson, 2021).

An important route to pursuing STEM-related careers is introducing STEM to students during their primary and secondary school years. Often, students may dismiss the option of pursuing STEM-related careers as they perceive them to be “too hard, too inaccessible, too elitist, too boring, or too unfashionable” (Committee for Economic Development, 2003). In addition to these misconceptions, stereotypes have historically been associated with scientists, such as scientists being required to identify as a certain gender, race, SES, or ability (Chambers, 1983; Committee for Economic Development, 2003; Finson et al., 1995; Shattuck & Cheney, 2020). Such misconceptions and stereotypes may negatively influence underrepresented students’ persistence to pursue STEM education and careers (Good et al., 2012; Lewis et al., 2017; Master & Meltzoff, 2020; Walton & Cohen, 2007).

Where barriers exist, diversity suffers (Ahn & Davis, 2020; Atkins et al., 2020; Benavent et al., 2020; Carlone & Johnson, 2007; Chen et al., 2021; Erkkila, 2019; Fry et al., 2021; Grossman & Porche, 2014; Gonsalves et al., 2021; Good et al., 2012; Leggon, 2010; Lewis et al., 2017; Maloy et al., 2022; Martin & Fisher-Ari, 2021; Master & Meltzoff, 2020; Shattuck & Cheney, 2020; Vaccaro et al., 2021). Significant research has shown CTE and STEM fields suffer by not bridging diverse HS students to STEM-related careers (Ahn & Davis, 2020; Atkins et al., 2020; Benavent et al., 2020; Chen et al., 2021; Erkkila, 2019; Fry et al., 2021; Gonsalves et al., 2021; Good et al., 2012; Lewis et al., 2017; Maloy et al., 2022; Master & Meltzoff, 2020; Vaccaro et al., 2021). In comparison to the general population, some demographic groups are represented less than others in STEM-related fields. Both qualitative and quantitative research have supported the statement that certain individuals experience exclusion and underrepresentation in STEM-related fields (CEOSE, 2020; Grossman & Porche, 2014; Martin & Fisher-Ari, 2021; Shattuck & Cheney, 2020).

Sense of Belonging

Underrepresentation occurs when systematic barriers and exclusionary practices exist (Martin & Fisher-Ari, 2021). Data indicated that there remains relatively little diverse representation in STEM-related fields in the U.S. in comparison to the growing diversity of the U.S. population (CEOSE, 2020; Johnson, 2021). White women, black men and women, Hispanic men and women, and American Indian/Alaska Native men and women, as well as men and women with disabilities are all underrepresented in STEM (NCSES, 2021; U.S. Census Bureau, 2021). Additionally, transgender and gender nonconforming (TGNC) individuals are not represented at all in most data sets (Maloy et al., 2022; Thorne et al., 2019).

As of 2024, 9.3% of U.S. adults identified as LGBTQ+, with over 1.3% identifying as TGNC—these percentages have increased each generation since the Baby Boomers (Jones, 2025). TGNC populations are underrepresented in STEM and may "experience pervasive harassment and discrimination, access barriers, and mental health concerns even more severely in STEM" (Maloy et al., 2022). Not only are TGNC populations underrepresented in STEM but continue to be discriminated against in the U.S. at large.

> Between a record number of anti-TGNC bills advancing in state legislatures, a hostile climate for TGNC students in higher education, and anti-TGNC bias permeating STEM fields, it is no surprise TGNC students in STEM report alienation from and disidentification with STEM. (Maloy et al., 2022, p. 1)

A lack of representation can convey the message that certain people are less qualified to belong to a certain group. When a person feels they do not or cannot belong to a certain group, it can be referred to as *belonging uncertainty* (Höhne & Zander, 2019; Walton & Cohen, 2007). Belonging uncertainty in academia and career paths can have many negative consequences. Individuals experiencing belonging uncertainty may have greater self-doubt, expectations of unfairness and rejection, lower self-worth, and, ultimately, a higher chance of self-removal from the group in which they are experiencing belonging uncertainty (Höhne & Zander, 2019; Walton & Cohen, 2007).

Opposite to belonging uncertainty is a sense of *belonging*. Belonging is a "generalized sense of membership that stems from students' perception of their involvement in a variety of settings and the support they experience from those around them" (Ahn & Davis, 2020). Belonging often results in positive academic and career experiences, higher self-confidence, increased academic achievement, and higher rates of persistence (Chen et al., 2021). As belonging is rooted in perception, it is crucial for future success to engage with individuals at a young age in developing positive perceptions of belonging. If an individual develops a perception, or sense, of belonging as an adolescent, it is likely to impact their identity and future choices (Dudovitz et al., 2017). One area to assess an adolescent's sense of belonging and identity would be through career aspirations. "Career aspirations might reflect an adolescent's emerging identity or values. Theories of archetype matching and activation suggest that people might adopt the stereotypical behaviors of archetypes that most closely match our own identities" (Dudovitz et al., 2017, para. 2). For example, a middle school student who identified with a veterinarian's career path may choose to engage with different stereotypical behaviors than one who identified with a video game developer's career path.

A lack of diverse representation in both STEM academics and occupations has been heavily noted in research (Connor et al, 2016; Erkkila, 2019; Fry et al., 2021; Gottfried & Sublett, 2017; Grossman & Porche, 2014; Liu & Schunn, 2020; Martin & Fisher-Ari, 2021; McRuer, 2006; Okrent & Burke, 2021; Shattuck & Cheney, 2020; Theobald et al., 2021; Vaccaro et al., 2021). A lack of diverse representation can contribute to belonging uncertainty in STEM for underrepresented groups. Belonging uncertainty can result in a lack of persistence to pursue an academic or occupational path, which, in turn, may perpetuate the lack of diversity in STEM-related fields. More research must be conducted to further explore this phenomenon.

Research Design and Methodology

This study was part of a larger research project which used a mixed-methods design. The instrument used in this study was developed in three stages. In each stage, the purpose, research questions, and instrument were slightly modified due to various identified limitations and analysis feedback. This manuscript only discusses a section of the quantitative portion of data collected.

In Spring 2024, a pilot study was conducted at the University of Idaho to develop a STEM identity assessment for undergraduate students. Cronbach's (1951) α was used to assess the reliability of the instrument constructs. In the study's pilot sample, the STEM identity scale had excellent internal consistency ($\alpha = .908$). Changes were made to each section of the STEM identity scale to raise α and/or to better align the survey items with the research framework and research questions. Validity was confirmed using Pearson's Correlation Coefficient (Schober et al., 2018).

This study was then conducted in August–September 2024. An email invitation to participate in the study was sent to each public Idaho post-secondary institution—Boise State University (BSU-1), College of Eastern Idaho (CEI-2), College of Southern Idaho (CSI-3), College of Western Idaho (CWI-4), Idaho State University (ISU-C5), Lewis Clark State College (LCSC-6), North Idaho College (NIC-7), and University of Idaho (UI-8). CEI ($N = 1591$), CSI ($N = 2574$), NIC ($N = 3609$), UI ($N = 800$) opted to share two email invitations with their undergraduate student population to participate in this study. ISU opted to share their email invitation via their student news email; this resulted in a participant response rate too low to use in this research ($n = 6$). BSU, C of I, and LCSC declined to participate.

The sampling from this study was a convenience sampling of undergraduate students enrolled at public Idaho post-secondary institutions. While convenience sampling is not generalizable to an entire population, it still provides significant information about the population (Cannon et al., 2024; Maddy & Cannon, 2014; Simkus, 2023). The quantitative data was analyzed using SPSS and Excel. Descriptive analyses were used to determine participants' STEM identity scores. Independent samples t-tests were then used to assess if there were significant differences in students' STEM identity scores and their demographic/academic variables. The final instrument had an overall α of .953. The *recognition* construct had a Cronbach's α of .904. The *performance and competence* area had a Cronbach's α of .863. The *interest* area had a Cronbach's α of .911. The *belonging* construct had a Cronbach's α of .876. Validity was confirmed using Pearson's Correlation Coefficient (Schober et al., 2018).

Findings

Research Question 1: What are the STEM identities of undergraduate students at public Idaho postsecondary institutions?

In this study, STEM identity was assessed in four areas: *recognition*, *performance and* *competence*, *interest*, and *belonging* (see Table 1).

Table 1
Idaho *Undergraduate STEM Identity Assessment*

STEM Identity Statements	**Mean (*M*)**	**Standard Deviation (*SD*)**
R1: I am good at STEM-related subjects because I work hard.	3.77	0.89
R2: My classmates think I am good at STEM-related subjects.	3.58	0.83
R3: Teachers of STEM-related subjects think I am good at STEM-related subjects.	3.63	0.80
R4: My family and friends think I am good at STEM-related subjects.	3.88	0.89
R5: I am naturally good at STEM-related subjects.	3.35	1.00
R6: My classmates would ask me for help with STEM-related content.	3.48	0.99
R7: I can achieve high levels of success in STEM-related subjects.	3.96	0.86
R8: I am confident that I will be able to learn STEM-related subjects in college.	4.11	0.78
P1: I can successfully use tools and equipment in lab classes.	4.11	0.78
P2: I can understand the laws and principles of STEM-related subjects.	3.88	0.77
P3: I can use science to explain occurrences in daily life.	3.90	0.81
P4: I can learn difficult STEM-related subjects if I try.	4.02	0.75
P5: I can earn good grades in STEM-related subjects.	3.98	0.76
P6: I am successful in STEM classes.	3.81	0.93
I1: I would like to learn more about STEM-related knowledge through various sources.	3.84	0.93
I2: I am interested in pursuing a STEM-related career.	3.63	1.16
I3: I like to participate in various STEM-related activities.	3.61	0.99
I4: The STEM-related knowledge I learn in the classroom is important in daily life.	3.79	0.89
I5: I plan to pursue a STEM-related academic or career path after college.	3.56	1.19
I6: I believe I will be more satisfied from STEM-related courses/careers than other courses/careers.	3.44	1.17
B1: I would be proud to do well in STEM-related subjects.	4.28	0.74
B2: Other people see me as a person who could work in a STEM-related field.	3.75	0.97
B3: I am willing to show my knowledge of STEM to others.	3.81	0.86
B4: I feel good when talking to others about content related to STEM subjects.	3.64	0.95
B5: I feel comfortable when talking to people who work in STEM-related fields.	3.61	0.95
B6: People like me work in STEM-related fields.	3.37	0.95

Each area contained statements that participants ranked on a five-point Likert scale from strongly disagree (1) to strongly agree (5). The statement, "I would be proud to do well in STEM-related subjects," (M = 4.28, SD = 0.74) had the highest mean for the STEM Identity Assessment. The lowest mean was for the statement "I am naturally good at STEM-related subjects" (M = 3.35, SD = 1.00).

Research Question 2: What are the differences by reported demographic/academic variables of undergraduate students' STEM identities at public Idaho post-secondary institutions?

The following demographics were analyzed to identify any significant differences in participant reported STEM identities. The academic demographics were Idaho HS graduate, CTE class participant, Career and Technical Student Organization (CTSO) member, and year at current institution. The personal demographics were gender, race, subjective social status (SSS), and disability. Of the participants, 62.00% graduated from HS in Idaho (n = 359) and 34.37% graduated from a non-Idaho HS (n = 199). Significant differences were identified in all areas (see Table 2).

Table 2
STEM Identity Differences: Idaho HS Graduates and Non-Idaho HS Graduates

STEM Identity Area Statement, *t(df) = test statistic, p = p-value*	Idaho Graduate Mean (*M*)	Idaho Graduate Standard Deviation (*SD*)	Non-Idaho Graduate Mean (*M*)	Non-Idaho Graduate Standard Deviation (*SD*)
*R1: I am good at STEM-related subjects because I work hard, $t(432.81) = 2.48$, $p = .013$	3.71	0.91	3.90	0.85
*R4: My family and friends think I am good at STEM-related subjects, $t(489.85) = 3.24$, $p = .001$	3.79	0.95	4.03	0.75
R5: I am naturally good at STEM-related subjects, $t(556) = 2.45$, $p = .014$	3.28	1.03	3.49	0.95
*P2: I can understand the laws and principles of STEM-related subjects, $t(430.86) = 2.65$, $p = .008$	3.82	0.78	3.99	0.74
P6: I am successful in STEM classes, $t(556) = 2.17$, $p = .031$	3.76	0.82	3.91	0.83
I2: I am interested in pursuing a STEM-related career, $t(556) = 2.02$, $p = .044$	3.56	1.14	3.77	1.19
I3: I like to participate in various STEM-related activities, $t(556) = 2.44$, $p = .015$	3.55	0.98	3.76	1.01
I5: I plan to pursue a STEM-related academic or career path after college, $t(556) = 2.06$, $p = .040$	3.49	1.17	3.70	1.22
*B2: Other people see me as a person who could work in a STEM-related field, $t(445.00) = 3.20$, $p = .001$	3.66	1.00	3.92	0.90
*B3: I am willing to show my knowledge of STEM to others, $t(441.38) = 3.65$, $p = <.001$	3.72	0.88	3.99	0.80
B4: I feel good when talking to others about content related to STEM subjects, $t(556) = 3.04$, $p = .002$	3.55	0.94	3.80	0.95
B5: I feel comfortable when talking to people who work in STEM-related fields, $t(556) = 3.93$, $p = <.001$	3.49	0.93	3.82	0.95
B6: People like me work in STEM-related fields, $t(556) = 2.50$, $p = .013$	3.30	0.94	3.51	0.96

*Indicates assumption of unequal variances

Of the participants, 65.80% participated in at least one CTE class in HS ($n = 381$) and 34.20% did not participate in at least one CTE class in HS ($n = 198$). There were significant differences in two areas (see Table 3).

Table 3
STEM Identity Differences: CTE Class Participants and Non-CTE Class Participants

STEM Identity Area Statement, *t(df) = test statistic, p = p-value*	CTE Class Participant Mean (*M*)	CTE Class Participant Standard Deviation (*SD*)	Non-CTE Class Participant Mean (*M*)	Non-CTE Class Participant Standard Deviation (*SD*)
R4: My family and friends think I am good at STEM-related subjects, $t(577) = 2.15$, $p = .032$	3.93	0.88	3.77	0.90
R6: My classmates would ask me for help with STEM-related content, $t(577) = 2.62$, $p = .009$	3.56	0.99	3.33	0.98
P1: I can successfully use tools and equipment in lab classes, $t(577) = 2.44$, $p = .015$	4.17	0.74	4.01	0.84
*P2: I can understand the laws and principles of STEM-related subjects, $t(348.27) = 1.96$, $p = .050$	3.93	0.72	3.79	0.85

*Indicates assumption of unequal variances

Of the 579 participants, 75.30% identified as not having been a member of a HS CTSO ($n = 436$), and 21.93% identified as having been a member of a HS CTSO ($n = 127$). There was a significant difference for *B6*, $t(561) = 2.73$, $p = .006$, with participants who participated in at least one CTE class in HS ($M = 3.58$, $SD = .95$) ranking themselves higher than those who did not participate in at least one CTE course in HS ($M = 3.32$, $SD = .94$).

Of the 579 participants, 46.98% reported being in their first year at their current institution (*n* = 272), 29.71% reported being in their second year (*n* = 172), 12.78% reported being in their third year (*n* = 74), 4.32% reported being in their fourth year (*n* = 25), and 3.45% reported being in their fifth year or more (*n* = 20). Statements indicated significant differences in the areas *performance and competence* and *interest* (see Table 4).

Table 4
STEM Identity Differences: First and Second Year at Current Institution

STEM Identity Area Statement, ***t(df) = test statistic, p = p-value***	**First Year Mean (*M*)**	**First Year Standard Deviation (*SD*)**	**Second Year Mean (*M*)**	**Second Year Standard Deviation (*SD*)**
P6: I am successful in STEM classes, $t(442) = 2.37$, $p = .018$	3.74	0.81	3.93	0.82
I4: The STEM-related knowledge I learn in the classroom is important in daily life, $t(295) = 2.67$, $p = .008$	3.84	0.85	3.36	0.91

*Indicates assumption of unequal variances

Statements indicated significant differences between those in their first and fifth year or more at their current institution (see Table 5).

Table 5
STEM Identity Differences: First and Fifth Year or more at Current Institution

STEM Identity Area Statement, ***t(df) = test statistic, p = p-value***	**First Year Mean (*M*)**	**First Year Standard Deviation (*SD*)**	**Fifth+ Year Mean (*M*)**	**Fifth+ Year Standard Deviation (*SD*)**
P1: I can successfully use tools and equipment in lab classes, $t(290) = 2.46$, $p = .015$	4.11	0.77	4.55	0.69
P4: I can learn difficult STEM-related subjects if I try, $t(290) = 1.99$, $p = .048$	3.99	0.78	4.35	0.67
B5: I feel comfortable when talking to people who work in STEM-related fields, $t(290) = 2.02$, $p = .044$	3.63	0.91	4.05	0.95

*Indicates assumption of unequal variances

Of the 579 participants, 92.57% identified as a binary gender (*n* = 536) and 5.35% did not identify as a binary gender (*n* = 31). There were significant differences between those who identified as female and those who identified as male in all STEM identity areas (see Table 6).

Table 6

STEM Identity Differences: Male Gender and Female Gender

STEM Identity Area Statement, ***t(df) = test statistic, p = p-value***	**Male Mean (*M*)**	**Male Standard Deviation (*SD*)**	**Female Mean (*M*)**	**Female Standard Deviation (*SD*)**
R2: My classmates think I am good at STEM-related subjects, $t(534) = 3.01$, $p = .003$	3.75	0.80	3.51	0.83
*R3: Teachers of STEM-related subjects think I am good at STEM-related subjects, $t(279.47) = 2.39$, $p = .017$	3.77	0.74	3.59	0.81
*R4: My family and friends think I am good at STEM-related subjects, $t(306.53) = 3.91$, $p = <.001$	4.10	0.75	3.79	0.91
R5: I am naturally good at STEM-related subjects, $t(534) = 3.24$, $p = .001$	3.58	0.99	3.27	0.98
R6: My classmates would ask me for help with STEM-related content, $t(534) = 2.97$, $p = .003$	3.64	0.96	3.42	1.00
R7: I can achieve high levels of success in STEM-related subjects, $t(534) = 2.97$, $p = .003$	3.90	0.83	3.65	0.88
R8: I am confident that I will be able to learn STEM-related subjects in college, $t(534) = 1.99$, $p = .047$	4.10	0.85	3.93	0.84
P1: I can successfully use tools and equipment in lab classes, $t(534) = 2.86$, $p = .004$	4.28	0.76	4.06	0.77
*P2: I can understand the laws and principles of STEM-related subjects, $t(313.37) = 5.24$, $p = <.001$	4.14	0.63	3.79	0.78
*P3: I can use science to explain occurrences in daily life, $t(320.44) = 4.62$, $p = <.001$	4.13	0.66	3.81	0.84
P4: I can learn difficult STEM-related subjects if I try, $t(534) = 3.43$, $p = <.001$	4.20	0.72	3.95	0.76
*P6: I am successful in STEM classes, $t(288.76) = 3.31$, $p = .001$	4.01	0.74	3.76	0.85
I1: I would like to learn more about STEM-related knowledge through various sources, $t(534) = 2.07$, $p = .39$	3.98	0.94	3.79	0.92
*B2: Other people see me as a person who could work in a STEM-related field, $t(267.66) = 3.10$, $p = .002$	3.97	0.91	3.69	0.96
*B3: I am willing to show my knowledge of STEM to others, $t(365.50) = 3.12$, $p = .002$	3.99	0.81	3.74	0.84
*B4: I feel good when talking to others about content related to STEM subjects, $t(278.57) = 2.35$, $p = .020$	3.77	0.85	3.57	0.97
*B5: I feel comfortable when talking to people who work in STEM-related fields, $t(287.63) = 4.57$, $p = <.001$	3.89	0.85	3.50	0.96
B6: People like me work in STEM-related fields, $t(534) = 3.41$, $p = <.001$	3.62	0.95	3.30	0.95

*Indicates assumption of unequal variances

One statement indicated a significant difference between participants who identified as female and participants who identified as a non-binary gender. There was a significant difference for *P3*, $t(421) = 2.06$, $p = .040$, with participants identifying as female ($M = 3.81$, $SD = .84$) ranking themselves lower than participants identifying as a non-binary gender ($M = 4.13$, $SD = .67$).

Statements indicated a significant difference between participants who identified as male and participants who identified as a non-binary gender (see Table 7).

Table 7
STEM Identity Differences: Non-Binary Gender and Male Gender

STEM Identity Area Statement, *t(df)* = test statistic, *p* = p-value	**Male Mean (*M*)**	**Male Standard Deviation (*SD*)**	**Non-Binary Mean (*M*)**	**Non-Binary Standard Deviation (*SD*)**
P2: I can understand the laws and principles of STEM-related subjects, $t(173) = 2.38$, $p = .018$	4.14	0.77	3.81	0.98
P5: I can earn good grades in STEM-related subjects, $t(173) = 2.62$, $p = .101$	4.10	0.78	3.68	0.95
P6: I am successful in STEM classes, $t(173) = 2.02$, $p = .045$	4.01	0.74	3.71	0.74
I6: I believe I will be more satisfied from STEM-related courses/ careers than other courses/careers, $t(173) = 2.53$, $p = .012$	3.62	1.18	3.00	1.46
*B2: Other people see me as a person who could work in a STEM-related field, $t(37.67) = 2.41$, $p = .021$	3.97	0.91	3.42	1.21
B6: People like me work in STEM-related fields, $t(173) = 2.44$, $p = .016$	3.62	0.95	3.16	0.90

*Indicates assumption of unequal variances

Of the participants, 73.75% identified as the institution's dominant race ($n = 427$) and 23.66% identified as a race other than the institution's dominant race ($n = 137$). There was a significant difference for *P4: I can learn difficult STEM-related subjects if I try*, $t(562) = 2.40$, $p = .017$, with participants identifying as the institutions' dominant race ($M = 4.06$, $SD = .74$) ranking themselves higher than participants identifying as a race other than the institutions' dominant race ($M = 3.88$, $SD = .79$).

Participants ($n = 579$) reported an average subjective social status as 4.85. Statements indicated significant differences between participants who identified as a five or below on the SSS and those who identified as a six or above (see Table 8).

Table 8
STEM Identity Differences: SSS Five or Below and SSS Six or Above

STEM Identity Area Statement, *t(df)* = test statistic, *p* = p-value	**SSS ≤5 Mean (*M*)**	**SSS ≤5 Standard Deviation (*SD*)**	**SSS ≥6 Mean (*M*)**	**SSS ≥6 Standard Deviation (*SD*)**
*R1: I am good at STEM-related subjects because I work hard, $t(552.54) = 3.26$, $p = .001$	3.68	3.91	3.91	0.81
R2: My classmates think I am good at STEM-related subjects, $t(577) = 3.49$, $p = <.001$	3.47	0.83	3.72	0.81
*R3: Teachers of STEM-related subjects think I am good at STEM-related subjects, $t(541.43) = 3.07$, $p = .002$	3.54	0.83	3.75	0.75
*R4: My family and friends think I am good at STEM-related subjects, $t(571.38) = 3.04$, $p = .002$	3.79	0.96	4.00	0.75
R5: I am naturally good at STEM-related subjects, $t(577) = 2.23$, $p = .026$	3.27	1.04	3.46	0.93
*R6: My classmates would ask me for help with STEM-related content, $t(558.92) = 2.15$, $p = .032$	3.41	1.05	3.58	0.89
*R7: I can achieve high levels of success in STEM-related subjects, $t(560.25) = 3.17$, $p = .002$	3.60	0.94	3.83	0.79
*R8: I am confident that I will be able to learn STEM-related subjects in college, $t(564.08) = 2.82$, $p = .005$	3.88	0.92	4.08	0.76
*P2: I can understand the laws and principles of STEM-related subjects, $t(569.21) = 2.29$, $p = .022$	3.82	0.83	3.96	0.66
*P4: I can learn difficult STEM-related subjects if I try, $t(576.07) = 3.55$, $p = <.001$	3.93	0.83	4.14	0.61
*P5: I can earn good grades in STEM-related subjects, $t(569.84) = 4.42$, $p = <.001$	3.87	0.81	4.14	0.64
*P6: I am successful in STEM classes, $t(569.16) = 4.18$, $p = <.001$	3.70	0.88	3.98	0.70

*Indicates assumption of unequal variances

Of the participants, 20.73% identified as having a disability (*n* = 120) and 71.85% did not identify as having a disability (*n* = 416). Statements indicated significant differences in three areas (see Table 9).

Table 9
STEM Identity Differences: Disability and No Disability

STEM Identity Area Statement, ***t(df) = test statistic, p = p-value***	**Disability Mean (*M*)**	**Disability Standard Deviation (*SD*)**	**No Disability Mean (*M*)**	**No Disability Standard Deviation (*SD*)**
R6: My classmates would ask me for help with STEM-related content, $t(534) = 1.98$, $p = .048$	3.33	1.04	3.53	0.96
*R7: I can achieve high levels of success in STEM-related subjects, $t(178.39) = 2.11$, $p = .036$	3.54	0.96	3.75	0.87
*R8: I am confident that I will be able to learn STEM-related subjects in college, $t(170.42) = 2.40$, $p = .018$	3.78	0.97	4.02	0.82
*P6: I am successful in STEM classes, $t(180.97) = 2.01$, $p = .046$	3.68	0.87	3.85	0.80
I3: I like to participate in various STEM-related activities, $t(534) = 2.32$, $p = .021$	3.56	0.99	3.80	0.98

*Indicates assumption of unequal variances

Discussion

STEM Identities: Across Idaho

In this study's first research question, data were explored to provide insight into the STEM identities of undergraduate students at public Idaho post-secondary institutions. The first area of STEM identity area was *recognition*, consisting of eight statements. The STEM identity for this area for all participants was slightly positive. The overall mean score of 4.11 for *R8* was a positive indicator for student motivation toward success, especially as they ranked *R5* as their lowest statement in this area. This indicated that participants were willing to work toward their goals, even if they did not identify them as natural skills.

The second STEM identity area was *performance and competence*, consisting of six statements. The STEM identity for this area for all participants was slightly positive. While participants ranked themselves highest in *P1,* they ranked themselves lowest in *P6*. This may indicate that participants were more comfortable working in hands-on settings (performance) than in cognitive-based settings (competence). With *P4* ranked second highest though, it indicated that even though participants may struggle to be successful in STEM classes, they have confidence they will learn the content if they try.

The third area of STEM identity area was *interest*, consisting of six statements. The STEM identity for this area for all participants was slightly positive but had a larger standard deviation than the other three areas. While data indicated that participants were interested in learning STEM-related knowledge, they were less confident in pursuing a STEM-related career—and even less confident in finding satisfaction in the case they did pursue a STEM-related career. This may be an indicator that there is a gap in bridging individuals' STEM-related interests into actual careers.

The fourth area of STEM identity area was *belonging*, consisting of six statements. The STEM identity for this area for all participants was slightly positive. The quote that inspired this study was, “Representation always matters. There's the whole saying of, “if you see it, you can be it” (Shattuck & Cheney, 2020). Participant responses in this area indicated that they were not “seeing it” though. While the highest-ranking statement of all four sections was *B1*, the second lowest was *B6*. This indicated that participants attached value to STEM-related success, but that they did not feel an actual sense of belonging in STEM-related fields. Participants identified that others could see them as a person who could work in a STEM-related field though. This indicated that while they currently do not see people like themselves working in STEM-related fields, they believe they are still capable of entering those fields.

STEM Identities: Academic and Personal Demographics

Eight demographic/academic variables were collected from participants and analyzed for significant differences against their reported STEM identities: 1) STATE HS graduate, 2) CTE class participation, 3) CTSO membership, 4) year at current institution, 5) gender, 6) race, 7) SSS, and 8) disability. Data analysis indicated that Idaho HS graduates ranked themselves significantly lower in three of the *recognition* statements. Experiencing a lack of recognition can result in a lack of motivation to persist in achieving short- and long-term goals. Interestingly, Idaho HS graduates ranked themselves lower in both being good at STEM-related subjects due to working hard and being naturally good at them. This may indicate that Idaho HS graduates viewed themselves as not good at STEM-related subjects in general. Idaho HS graduates also ranked themselves significantly lower in perceiving family/friends thinking they are good at STEM-related subjects. Combined, these three statements indicated that students who graduated from Idaho HSs had a lower level of recognition-based confidence than their peers who graduated outside of Idaho.

Data analysis also indicated that Idaho HS graduates ranked themselves significantly lower in three *performance and competence* statements. These statements further supported the indications from the *recognition* statements. Participants graduating from Idaho HSs ranked themselves significantly lower at understanding STEM-related concepts, using them in practical applications, and finding success in STEM-related classes. Additionally, data analysis indicated that Idaho HS graduates ranked themselves significantly lower in three *interest* statements. Lower rankings in these statements indicated that Idaho HS graduates are less interested in STEM-related careers, less likely to engage in STEM-related activities, and are less likely to plan to pursue a STEM-related career after college than their out-of-state HS graduate peers. In alignment with the responses for *recognition* and *performance and competence*, Idaho HS graduates may not be interested in pursuing STEM-related careers due to lower levels of recognition-based confidence, as well as lower levels of competence and performance abilities in STEM-related content.

Data analysis also indicated that Idaho HS graduates ranked themselves significantly lower in five of the six *belonging* statements. A sense of belonging may be a strong indicator of engagement. A lower sense of belonging in five of six statements supports the three other STEM identity areas, indicating that Idaho HS graduates had a lower likelihood of successfully pursuing STEM-related goals than their out-of-state HS graduate peers.

Data analysis indicated that participants who participated in at least one CTE class in HS ranked themselves significantly higher in two *recognition* and two *performance and competence* statements. As assessments in CTE are typically performance-based, a large component of CTE classes is to engage in practical learning with a focus on engaging with community. Students who have experienced this type of engagement during HS may feel strong recognition-based confidence with STEM-related content. Data analysis indicated that participants who identified as having been a member in a CTSO in HS ranked themselves significantly higher in *B6.* A requirement of many CTSOs is to engage in career-related experiences. By exploring and networking within STEM-related careers during HS, an individual may be more likely to build a positive sense of belonging within STEM-related fields.

Data analysis indicated significant differences between students in their first and second years at their current institution in one *performance and competence* statement, with first-years ranking themselves lower in *P6.* Students in their first year at an institution may struggle to adjust to the rigor of college coursework, especially in STEM-related courses that may include both classroom and laboratory work. As second-year students ranked themselves higher in this statement, it may indicate a learning curve between the first and second year of college, in which students build *performance and competence* skills in STEM-related courses.

Data analysis additionally indicated significant differences between students in their first and fourth years at their current institution in one *interest* statement, with first-year students ranking themselves higher in *I4.* Often, first-year students enroll in general education or basic level STEM-related courses. These courses may relate more to day-to-day life experiences. For example, UI offers "Core Science" courses for non-STEM majors to fulfill their STEM-related degree requirements. First-year students engaging in these courses may perceive them as more applicable to daily life than those in advanced STEM-related courses. Data analysis also indicated significant differences between students in their first and fifth year or more at their current institution in two *performance and competence* statements, with first-year students ranking themselves lower in *P1* and *P4*. First-year students also ranked themselves lower than students in their fifth year or more in one *belonging* statement *B5.* Like the difference in *interest*, these are also likely due to hands-on experiences in the classroom, laboratory, and field. It would be expected for students who have persisted in a program for five or more years to rate themselves at higher levels of performance, competence, and content-related communication than those in their first year.

Data analysis indicated participants who identified as male ranked themselves significantly higher than those who identified as female in seven of the eight *recognition* statements. The only statement without a significant difference in *recognition* was *R1*. These differences support most existing research which indicated that individuals who identify as female experience lower levels of *recognition* than their male-identifying counterparts. While progress has been made, the significant differences shown in this data indicated that female-identifying individuals continue to have lower recognition-based confidence levels than their male-identifying peers.

Data analysis also indicated male-identifying participants ranked themselves significantly higher than female-identifying in five of the six *performance and competence* statements. While female-identifying participants ranked themselves significantly lower across the board in both *recognition* and *performance and competence* related to their male-identifying peers, they did not rank themselves significantly lower in the statements indicating that they could earn good grades in STEM-related subjects because they worked hard. This may indicate that female-identifying participants experience less external recognition-based confidence, which then may negatively impact their internal confidence in performance and competence.

Data analysis also indicated participants who identified as male ranked themselves significantly higher than those who identified as female in in five of the six *belonging* statements. The only statement without a significant difference in *belonging* was *B1.* If an individual does not perceive a sense of belonging in an area, they are likely not experiencing positive recognition in their *performance and competence* skills. For the area of *interest*, data analysis indicated significant differences between male-identifying participants and female-identifying participants in one of the six statements, with male-identifying participants ranking themselves higher in *I1*. *Interest* was the only area in which female-identifying participants did not rank lower than male-identifying participants in most statements. This indicated that there was very little difference in the level of interest between genders in STEM-related fields.

The findings showed participants who identified as male ranked themselves significantly higher than those who identified as a non-binary gender in three *performance and competence* statements. The statements indicated that male-identifying participants could understand STEM-related content, earn good grades in STEM-related courses, and be successful in STEM-related courses more than their peers who identified as a non-binary gender. Additionally, male-identifying participants reported that they would be more satisfied from a STEM-related academic/career path. These differences may be explained by the significantly lower rankings in *belonging* by participants who identified as a non-binary gender. The lower rankings indicated that non-binary-gender-identifying participants perceived others could not see them as a person who could work in a STEM-related field. Participants who identified as a non-binary gender also reported that people like them did not work in STEM-related fields. It was also found that there was a significant difference between participants who identified as female and those who identified as a non-binary gender in one *performance and competence* statement, with participants who identified as female ranking themselves lower in *P3*. There were no other indicators apparent in this data as to why this significant difference existed. Additionally, due to the current lack of research on individuals who identify as non-binary genders, we can only speculate on the possibility of trends beyond this study.

Data analysis indicated participants who identified as the institution's dominant race ranked themselves significantly higher in one *performance and competence* statement, *P4*. Little additional insight was provided in the data to further explore this significant difference. Race was rarely discussed in the data. Additional, more specific, data collection is necessary to further understand correlations between race and STEM identities.

Data analysis indicated participants who identified as ≤5 on the SSS ranked themselves significantly lower than those who identified as ≥6 in all eight *recognition* statements. Participants who identified as ≥6 also ranked themselves significantly higher in four of the six *performance and competence* statements. There were no significant differences in the areas of *interest* or *belonging*, which may indicate that while similar levels of *interest* and *belonging* existed between the two groups, their perceived social status negatively impacted their *recognition*-based confidence, as well as their levels of *performance and competence* abilities in STEM-related content. A correlation may exist with income-based opportunities. Families with lower incomes have less disposable income to spend on STEM-related opportunities. Less engagement with STEM-related experiences may result in lower recognition-based confidence and competence/performance abilities in STEM-related areas. Reported SSS did not indicate a significant difference in levels of *interest* and *belonging* though. This may indicate that individuals in lower-income families need support in accessing STEM-related experiences.

Data analysis indicated significant differences between participants who identified as having a disability and those who identified as not having a disability in three *recognition* statements, with participants who identified having a disability ranking themselves lower in each. Each of the *recognition* statements were classroom-based. Participants with a disability reported that they could achieve success in STEM-related subjects, learn STEM-related subjects, and be asked for help by their classmates in STEM-related subjects significantly lower than their peers who did not report a disability. Participants with a disability also ranked themselves lower in *performance and competence*, referring to their success in STEM-related classes, and in *interest*, referring to their participation in STEM-related activities. This was the only demographic whose significant differences in STEM identities entirely revolved around the classroom experience. This may indicate that classroom-specific barriers exist for individuals with disabilities.

Conclusion

Quantitative data analysis indicated that, overall, undergraduate students at Idaho post-secondary institutions had slightly positive STEM identities, with areas ranked high to low: *performance and competence* ($M = 3.95$, $SD = .79$), *belonging* ($M = 3.74$, $SD = 0.95$), *recognition* ($M = 3.67$, $SD = .91$), and *interest* ($M = 3.65$, $SD = 1.07$). Data also indicated that there were significant differences in STEM identities for all academic/personal demographics explored. This research can be used as a baseline to inform future research on personal and STEM identities for undergraduate students in the state of Idaho and beyond. It is recommended that stakeholders use the findings when reviewing and revising STEM curricula and creating engaging activities to improve student experiences.

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