Intersecting Identities: A Look at How Ethnic Identity Interacts With Science Identity in Native Hawaiian and Pacific Islander Students

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ABSTRACT

Understanding the experiences of Native Hawaiian and Other Pacific Islander (NHPI) students in science courses can help us foster inclusivity and belonging for these often excluded and unacknowledged students. Using social influence theory as a framework, we investigated the intersection between ethnic-racial identity and science identity in NHPI students to better understand their experiences in undergraduate Biology courses. We collected both quantitative and qualitative data and used concurrent triangulation design in our mixed-methods approach. Quantitative data include measures of student pre- and post-course science identity, self-efficacy, alignment with science values, sense of belonging, environmental concern, strength of ethnic-racial identity, and the interaction between ethnic-racial and science identity. We measured environmental concern because NHPI cultures often have strong connections with the environment that may overlap well with environmental science values. Qualitative data included short responses to survey questions that asked students to describe the interaction between their science identity and their ethnicity. We found that NHPI and non-NHPI students do not significantly differ in any construct we measured, nor do they experience different gains across a semester when comparing pre- and post-scores. We also found that NHPI students' feelings concerning the intersection of their ethnic and science identities are varied and complex, with some students expressing feelings of conflict and many others expressing a strengthening relationship between those identities. We discuss implications for instructors and encourage them to acknowledge the community culture of wealth NHPI students bring to the classroom because of their ethnic-racial identities.

INTRODUCTION

Diversity in Science, Technology, Engineering, and Mathematics (STEM) is increasingly sought after as these fields try to achieve equity and understand how systemic racism impacts the representation of historically excluded groups (Miriti, 2020; Wilson-Kennedy *et al.*, 2020). The responsibility has often been wrongfully placed on marginalized students to increase their representation in STEM, but more awareness around this issue and increased understanding of exclusion has helped to shift the responsibility for reform to the system itself (Lett and Wright, 2003; Woodcock *et al.*, 2012; Montgomery, 2020a, 2020b; Whitcomb *et al.*, 2021). Just as microbiologists alter the laboratory environment to allow "unculturable" microbes to thrive, we must evaluate whether our learning environments foster growth for all students (Stewart, 2012; Montgomery, 2020a). Even with substantial funding aimed at increasing diversity in STEM (Miriti, 2020), there are still discrepancies between the diversity of students majoring in STEM and the diversity of those working in STEM, with Scholars of

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Color continuing to be strongly underrepresented (National Science Foundation, 2019; Miriti, 2020).

These discrepancies likely are due to the unique barriers that people who are excluded because of their ethnicity or race (PEERs) face (Allen-Ramdial and Campbell, 2014; Asai, 2020; Whitcomb *et al.*, 2021). Social barriers include marginalization, negative stereotypes, lowered expectations, conflicts within family life, conflicts from disconnecting with culture, and/or financial barriers due to socioeconomic status (Allen-Ramdial and Campbell, 2014; Alonzo *et al.*, 2019; Osakwe *et al.*, 2022). PEERs may also face psychological barriers, such as feelings of invisibility, isolation, rejection, hidden racism, unintentional discrimination, and stress in school, all of which can result in lowered sense of belonging (Lett and Wright, 2003; Strayhorn *et al.*, 2013; Alonzo *et al.*, 2019). Additionally, they are burdened with institutional barriers, including less precollege preparation, competitive-gatekeeper courses, fewer opportunities to apply what they learn, intimidation, discrimination, alienation, little or no institutional support, inadequate mentoring, lack of same-race peers or faculty, achievement gaps, and an overemphasis on student deficits due to a lack of cultural competency and awareness (Lett and Wright, 2003; Espinosa, 2011; Leggon, 2011; Strayhorn *et al.*, 2013; McGee, 2016; National Academies of Sciences, Engineering, and Medicine, 2016; Alonzo *et al.*, 2019; Canning *et al.*, 2019; Miriti, 2020). These barriers contribute to the "leaky pipeline," wherein increased opposition and systemic issues disproportionately cause some students to "leak out" of the academic pipeline more than others (Barr *et al.*, 2008).

If our goal is to promote equity in STEM, these inequitable barriers need to be addressed. As educators, we can and must consider the institutional barriers that deny some students the conditions they need to thrive in STEM (Asai, 2020; Miriti, 2020; Montgomery, 2020a; Whitcomb *et al.*, 2021; Pearson *et al.*, 2022). Breaking these barriers can promote success for everyone (Montgomery, 2020a) and increase diversity, which is known to generate unique perspectives that contribute to new questions, ideas, innovations, problem-solving, and a better ability to prevent biases, all of which are indispensable in STEM fields (Kimmerer, 2002; Uriarte *et al.*, 2007; Ostrom, 2008; Intemann, 2009; Perez and Hogan, 2018; Evangelista *et al.*, 2020; Miriti, 2020).

Focusing in on Native Hawaiians and Other Pacific Islanders (NHPI) Students

Native Hawaiians and Other Pacific Islanders (NHPIs) are among the most underrepresented groups in science, yet they are the least acknowledged (Kerr *et al.*, 2018; Teranishi *et al.*, 2020). NHPI underrepresentation can be difficult to quantify as they are frequently included with Asian Americans in federal agency initiatives (Kerr *et al.*, 2018), despite legal disaggregation and "NHPI" becoming an official U.S. census category in 2000 (Taparra, 2021; Taparra *et al.*, 2021). Data we do have show that, in 2020, only 52.7% of NHPIs seeking a Bachelor's degree had graduated, compared with 67.8% of white students (National Center for Educational Statistics, 2020). In 2019, only 4.1% of Native Hawaiian people and only 4.5% of Pacific Islander people had earned a graduate or professional degree, compared with 9.2% of white people, 16.3% of Asian people, and 5.6% of Black people (United States Census Bureau, 2019). As of 2017, there were fewer than 10,000 Native Hawaiians with any kind of graduate degree and less than 500 that held a STEM doctorate (Kamehameha Schools, 2014; Office of Hawaiian Affairs, 2017; Baker *et al.*, 2021). For STEM degrees specifically, NHPIs may be subject to the leaky pipeline described above (Barr *et al.*, 2008; James *et al.*, 2012), as they are represented in Bachelor's and Master's programs, but underrepresented in doctoral degrees (National Center for Science and Engineering Statistics, 2021). The trend is similar in STEM jobs; from 2006–2010 NHPIs held only 0.09% of all STEM jobs nationwide, though NHPIs of working age (16 and older) comprised 0.15% of the U.S. population during the same period (United States Census Bureau, 2011; Baker *et al.*, 2021). This is also the case in medicine, as NHPIs are the least represented racial group in U.S. medical schools (Taparra, 2021; Association of American Medical Colleges, 2022).

In Hawai‘i, Native Hawaiians face significant levels of poverty and deal with underfunded public school systems, which rank significantly below the national average in science proficiency (Sakai *et al.*, 2008; Kaholokula *et al.*, 2010; Liu and Alameda, 2011; Kaholokula *et al.*, 2013; Kamehameha Schools, 2014; James *et al.*, 2017; Office of Hawaiian Affairs, 2017; Baker *et al.*, 2021). The mean science proficiency for students in Hawai‘i between 2016–2019 showed 30% of Native Hawaiians and 23.1% of other Pacific Islanders were proficient in science, below the state average of 45.4%. NHPI students' science proficiency was well below other ethnicities, with 61.7% of white students and 64.6% of Asian students (excluding Filipinos) being proficient in science. (Hawaii State Department of Education, 2019; Baker *et al.*, 2021). These issues extend to other islands across the Pacific as well (Baker *et al.*, 2021).

Other barriers unique to NHPI students in STEM may include geographic isolation (resulting in decreased access to schools), undertrained and underfunded teachers and schools (especially in STEM), financial barriers (due to traveling from their home islands to attend high school or college), and cultural barriers (such as familial obligations and traditional/religious restrictions; Kerr *et al.*, 2018). Although there is some awareness around these challenges, there is a need for more research on NHPI student experiences in science that can help us better address barriers that are in our realm of influence (Benham, 2006; Saelua *et al.*, 2017). Below we outline the theoretical framework that guided our study, review similar studies done in other populations, and outline our research questions.

Theoretical Framework

Social Influence Theory. Social influence theory has been used to study minority students' integration into the scientific community, though the populations have been predominantly Black and Hispanic students (Estrada *et al.*, 2011; Hanauer *et al.*, 2016; Estrada *et al.*, 2018; Hernandez *et al.*, 2018). This theory originated as Herbert Kelman's Tripartite Integration Model of Social Influence and proposes that a person's integration into a social construct can be influenced by other people and by social contexts (Kelman, 1958, 2006). Kelman's model includes three "influencing agents": 1) rule orientation, 2) role orientation, and 3) values orientation, which impact ones' integration into a social group (Kelman, 1958, 2006). Successful integration is shown by "greater efficacy to engage in normative behaviors, stronger identification with the (group), and internalization of that group's values" (Hernandez *et al.*, 2020, p. 3).

Estrada *et al.* (2011) adapted social influence theory to define three processes that measure integration into the scientific community. These are: 1) identity (do I see myself as a scientist?), 2) self-efficacy (can I do the science?), and 3) internalization of values (do I agree with the values of the scientific community?). Thus, when the proposed-influencing agents of identity, efficacy, and internalization of values are increased, it would suggest deeper integration into the scientific community (Hernandez *et al.*, 2020; Estrada *et al.*, 2011). This was validated with evidence that interventions that supported and expanded student science identity, efficacy, and motivation led to increased persistence of Hispanic students (Estrada *et al.*, 2011). Because Estrada's (2011) model of social influence has never been tested on NHPI populations, we chose to use it as a framework to evaluate the integration of NHPI students into the scientific community. As NHPI students are underrepresented in science, we hypothesized that their integration (and thus their scores on the measures outlined by Estrada) could be lower than their non-NHPI peers.

Furthermore, Estrada and colleagues (2011) found that developing strong science identity and aligning with the values of the scientific community predicted a deeper integration and motivation to persist in science than students' self-efficacy alone. Thus, we chose to take a deeper dive into the identity aspect of social influence theory, specifically. Because Estrada *et al.* (2011) describe an important interplay between sense of belonging and science-identity development, we chose to measure sense of belonging in addition to the construct of science identity. The importance of belonging when studying PEERs in STEM is also supported in other literature (reviewed in Strayhorn, 2018). Additionally, we considered how other important identities might interact with science identity development for marginalized students.

A Model of Science Identity for Marginalized Students. Carlone and Johnson (2007) published a model for understanding the relationship between science identity and racial, ethnic, and gender identities. They illustrate three dimensions of science identity: 1) competence with science content, 2) performance of relevant scientific practices, and 3) recognition (recognizing oneself and getting recognized by others as a "science person"; Carlone and Johnson, 2007, p. 1191). This model argues that students' competence and performance are relevant to science identity development when they are recognized by others whose opinion is meaningful to them as a science person. Their model was created from a longitudinal analysis of the experiences of Women of Color in STEM–-however, there were no NHPI women in their sample. They found that Women of Color exhibited three distinct types of science identities: 1) research science identities, 2) altruistic science identities, and 3) disrupted science identities. Women with research science identities were enthusiastic about "science for science's sake" (p. 1197) and consistently received recognition. Those with altruistic science identities cared "less about science itself and more about using science as a vehicle for altruistic ambitions" (p. 1199). Finally, women with disrupted science identities were more aware of their membership in a stigmatized group and felt that this membership prevented them from being recognized as a good scientist or as a "science person." Thus, ethnic-racial and science identities likely impact each other in complex ways, and there is a need to increase our understanding of the relationship between them.

Ethnic-Racial Identity (ERI). Ethnicity refers to a cultural heritage of shared traditions, customs, and language, whereas race refers to historically defined divisions that are made by observable characteristics due to phenotype, ancestral bloodline, skin color, and/or other hereditary traits (Helms, 1990; Cokley, 2007; Umaña-Taylor *et al.*, 2014; Umaña-Taylor and Douglass, 2017; Juang *et al.*, 2021) Ethnic and racial identities are similar in that they both consist of a sense of belonging to a group and the groups' associated cultural values, an individual's perception of their identified group, and their behaviors as influenced by their perceived identity association (Guido-DiBrito and Chavez, 1999; Phinney and Ong, 2007; Kyere and Boddie, 2021; Kyere *et al.*, 2021).

Ethnic and racial identities are difficult to separate from each other, so they are often experienced and therefore studied together (Umaña-Taylor *et al.*, 2014; Juang *et al.*, 2021). This has resulted in the meta-construct of ERI, which incorporates aspects of both ethnic and racial identities together (Umaña-Taylor *et al.*, 2014; Umaña-Taylor and Douglass, 2017; Juang *et al.*, 2021). ERI can be thought of as how meaningful a person's membership in their ethnic-racial group is to them and develops as they explore this identity and achieve a sense of resolution regarding it (Sellers *et al.*, 1998; Rivas-Drake *et al.*, 2014; Umaña-Taylor and Douglass, 2017; Kyere and Boddie, 2021; Kyere *et al.*, 2021;). Similar to the conceptualizations of general identity formation, it is believed that ERI development evolves over the course of a person's life (Phinney, 1993; Phinney and Kohatsu, 1997; Syed and Mitchell, 2013, 2016; Umaña-Taylor and Douglass, 2017; Syed and Fish, 2018).

Context is important to consider when studying ERI, as this identity can be greatly influenced by region and a groups' history in a place (Salzman, 2005; Kaholokula, 2007; Borell *et al.*, 2018; Rogers, 2018; Syed and Fish, 2018; Juang *et al.*, 2021; Moffitt *et al.*, 2021). In the United States, for example, white Americans' ethnic identity is generally unnoticed and is often associated with "standard" culture rather than "ethnic" culture. Many white Americans are thus privileged with learning environments and societies that encompass the cultural norms of their ethnicity and race. Alternatively, individuals from other ethnic groups often experience learning environments that do not consider their cultural norms which can create conflict for these students (Guido-DiBrito and Chavez, 1999; Whitcomb *et al.*, 2021). Studies on ERI have found that when youth explore the meaning of their ERI and what this identity implicates for their lives, they experience better adjustment, clarity, and other psychological benefits (Phinney and Kohatsu, 1997; Umaña-Taylor *et al.*, 2004; Ponterotto and Park-Taylor, 2007; Rivas-Drake *et al.*, 2014; Umaña-Taylor *et al.*, 2014; Umaña-Taylor and Douglass, 2017; Batyrshina *et al.*, 2021). Research suggests that ERI among NHPIs is uniquely valuable and robust. For example, Allen and colleagues (2013) found that biracial NHPI individuals identified more with their NHPI parent in regard to their culture, language, customs, and cultural practices than their white parent counterpart. For this reason, we hypothesized that ERI could be an important factor in science identity formation and thus integration into the science community for NHPI students.

Interactions Between ERI and Science Identity. In studying the influence of ERI on science identities, findings have been mixed. We found studies that report no relationship between ERI and science identity for students (Lavakumar, 2021; Nhien, 2022), a conflicting relationship between ERI and science identity (Beeton, 2007; Gibbs Jr *et al.*, 2014; Robinson *et al.*, 2018; White *et al.*, 2019), the potential for ERI to be leveraged by students to support their science identity (Brown, 2017; Sumabat Estrada, 2020; Chen *et al.*, 2021), and finally, the potential for ERI to interact with science identity in a variety of ways, both strengthening and conflicting (Tran, 2011; Morton and Parsons, 2018; Rosa, 2018). Vincent-Ruz (2019) found that context is very important for all ethnicities in the development of science identity amongst adolescents. However, none of these studies involved NHPI populations.

Based on the literature regarding the connection of Indigenous people and their land (Kimmerer, 2002, 2012, 2013; McGregor, 2004a, 2004b), we hypothesized that NHPIs may experience a strengthening relationship between their ERI and their science identity. Like other Indigenous cultures, NHPI cultures are uniquely adapted to their environments and have a focus on sustainability and connection with the earth (Kerr *et al.*, 2018). Thus, we hypothesized that NHPI students' science identities would be strengthened by their ERI as they saw an overlap between their cultural values and science.

Research Questions

In summary, while there has been a lot of research on other marginalized groups' integration into science, research on NHPIs has been largely absent. Thus, we used Estrada's *et al.* (2011) model of social influence as a framework to help evaluate how NHPI students' integrate into science, then took a deeper look into the identity portion of the theory.

Our study seeks to answer these main questions:

1. Do NHPI students differ from non-NHPI students in terms of predictors of science persistence (i.e., science identity, internalization of scientific community values, self-efficacy, sense of belonging)?
2. Are NHPI students' science identity, internalization of scientific values, self-efficacy, and sense of belonging impacted differently over the course of a science class than non-NHPI students?
3. How do NHPI students perceive the relationship to be between their ethnic and science identities?
4. Do NHPI students differ from non-NHPI students in terms of environmental concern, and does this influence the relationship between NHPI students' ethnic and science identities?

METHODS

Mixed-Methods Approach

We employed concurrent-triangulation design (Kroll and Neri, 2009) as our mixed-methods approach, using surveys to gather both quantitative and qualitative data. Our separate quantitative and qualitative analysis approaches are described below. We then integrated our quantitative and qualitative findings in the interpretation phase of the study.

Ethics Statement

Ethics approval was first granted by Brigham Young University's Institutional Review Board (Study #E2020-347), and we then got approval from each institution's review board from which we recruited student participants. All study participants consented to be included in the study. All instructors except one chose to provide extra credit to their students for participating in the study (up to 2% of their final grade). An alternative form of extra credit that was of equal value was available for students who did not wish to participate in the study. The professor who did not offer extra credit had very few students participate.

Participant Recruitment and Inclusion Criteria

We invited 42 undergraduate biology instructors from 18 different institutions to participate in the study. We reached out to every university in Hawaiʻi because of our focus on NHPI students, and we used institutions in the Western United States because of our connections with those institutions. Twelve instructors from five different institutions agreed to distribute the surveys in their classes. Three of these institutions were minority-serving institutions, and the other two were primarily white. Two of the universities in our sample are private, religious institutions. Thus, students from two of our five institutions likely share a religious context, which could impact how they responded to our surveys. This is further discussed in our limitations section.

Surveys were distributed electronically via Qualtrics (Qualtrics, Provo, UT) at the beginning and end of the Fall 2020 and Spring 2021 semesters. In total, 967 students from 27 courses agreed to participate, but 243 students were excluded for providing unusable survey responses, leaving an overall sample size of 724. We had an average survey response rate of 42.5% and an average-survey completion rate of 82.75%. Table 1 shows final participant demographics. Our study did not ask what state students were from, so we were unable to determine how many of the 43 American NHPI students were from the state of Hawaiʻi.

Any student that completed the presurvey was included in analyses regarding student characteristics upon course entry. Students who did not take both surveys were excluded from longitudinal analyses because we could not measure their change over a semester. Students' short-answer responses were always included in qualitative analyses, even if they only took one of the surveys (pre or post).

Data Collection

We first asked students to report demographic information, which allowed us to compare students of different backgrounds and to examine the intersection of their various identities. The following instruments were included in both the pre- and the postsurveys, unless otherwise noted, and made up our quantitative data collection. Open-response follow-up questions were included to provide us with deeper, qualitative data about similar topics. For full surveys, see Supplemental Materials.

Instruments included in Surveys.

Science identity. To measure science identity, we used a modified version of the Scientific Identity Scale (Chemers *et al.*, 2010) which includes five items that have participants mark on

TABLE 1. Population Demographics

Variable	Non-NHPI	NHPI[†]	Subtotal
Gender			
Female	373	46	419
Male	275	23	298
Other	6	1	7
Home country			
International			
Polynesia	2	18	20
Other	88	9	97
United States	564	43	607
Major[‡]			
STEM	465	47	512
Non-STEM or undeclared	183	23	206
Semesters of college completed			
0–3	328	31	359
4–6	163	21	184
7–9	119	11	130
10+	44	7	51
Surveys completed			
Presurvey only	462	38	500
Postsurvey only	5	0	5
Both	187	32	219
Total	654	70	724

[†]Includes 30 students who identified as NHPI only and 40 students who identified as NHPI and at least one other ethnicity.
[‡]Six students did not report their major.

a scale of one (strongly disagree) to five (strongly agree) to what extent each statement was true of them. When a person identifies as a scientist, it is more likely they will behave as a person would behave when pursuing a scientific career (Estrada *et al.*, 2011). Under Social Influence Theory, science identity arises from feelings of belonging amongst other scientists, affiliations with those in science, and a belief that science is an important aspect of one's identity (Estrada *et al.*, 2011).

Self-efficacy. To measure self-efficacy, we used the six-item scale from Estrada *et al.* (2011) that was modified from the original 14-item Scientific Self-Efficacy Scale (Chemers *et al.*, 2010). In addition to being a facet of Social Influence Theory, self-efficacy is one of the most widely studied psychological predictors for perseverance in a field (Estrada *et al.*, 2011).

Alignment with science values. To measure alignment with science values, we used the Scientific Community Objectives Value Scale that was created to assess the third component of Social Influence Theory (Estrada *et al.*, 2011). The scale was validated as a useful measure of how much subjects orient themselves with scientific community values (Estrada *et al.*, 2011). There are four items that ask respondents to rate how much the person in the description is like them. Alignment with science values was found to be more predictive of staying in science than self-efficacy alone (Estrada *et al.*, 2011).

Sense of belonging in science. To measure belongingness, we used the Math-Sense of Belonging Scale, adapted for Science (Good *et al.*, 2012). This is a five-item scale that asks respondents to mark how much they agree with statements about their feelings of belongingness in science. Sense of belonging is strongly associated with the perception that an academic activity is valuable, useful, and important (Freeman *et al.*, 2007; Trujillo and Tanner, 2014).

Ethnic-racial identities. To collect information on ethnic-racial identities, we used the Multigroup Ethnic Identity Measure-Revised (MEIM-R; Phinney and Ong, 2007). The MEIM-R is a generalizable scale designed to assess the strength of one's ethnic identity based on an individual's sense of belonging, perception of achieved identity, and individual involvement in ethnic norms (Phinney and Ong, 2007; Quintana, 2007). It is important to note that perception of ethnic identity can change over time and under different social conditions (Phinney and Ong, 2007). Models are continually being changed and developed to better align with measurements of ethnic identity as our perception of ethnic identity changes (Phinney and Ong, 2007), and multiple instruments exist to measure ethnic identity, such as the EIS (Umaña-Taylor *et al.*, 2004) and the CRIS (Cross Jr and Vandiver, 2001). However, the MEIM-R is well-used in ERI research and has been demonstrated to have excellent fit in independent-sample confirmatory factor analyses (Ponterotto and Park-Taylor, 2007). It is made up of six items that ask respondents to indicate the extent to which they agree or disagree with the statements. The MEIM-R measures respondents' level of exploration of their ethnic group and also delves into their commitment to their ethnic group (Vera *et al.*, 2011).

Intersection between ethnic and science identities. We asked students on both the pre- and postsurvey, "How does your ethnic identity influence your science identity?" They were asked to mark on a scale of 1 (conflicts a lot) to 5 (strengthens a lot). Because this was a single-question measure of this intersection, we also asked participants to explain their answer in an open-response format. By analyzing the written responses, we could better interpret the results from this item framed by Carlone and Johnson's (2007) theory of science identity.

The setup of our surveys and the subsequent results from students indicated to us that students were using the terms "ethnicity", "race", and "culture" interchangeably in their responses and used them to indicate their culture, race, ethnicity, or heritage. They likely used words that they understood to describe the same idea, so that is why we include aspects of culture, heritage, race, and ethnicity under one overarching definition: where a person comes from, based on their genetic heritage, and what traditions or knowledge impacted them or their life because of this identity.

Intent to pursue science careers. We also asked the question "To what extent do you intend to pursue a science-related research career?" This item had respondents rate their likelihood of pursuing a science-related career on a scale of 0 (definitely will not) to 10 (definitely will). We included this question because it has been found to be significantly correlated with behaviors that have been associated with pursuing a scientific career (Estrada-Hollenbeck *et al.*, and Schultz, 2009).

Environmental concern. To understand students' levels of environmental concern, we used a shortened version of the Revised

New Environmental Paradigm scale (NEP; Dunlap, 2008). The NEP is the most widely accepted instrument used to assess environmental attitudes (Dunlap, 2008). Due to the length of our survey, we shortened the instrument to include 10 items instead of the 15 items found on the Revised NEP. Our shortened version contained two questions for each hypothesized facet, with one positive and one negative. These facets include limits to growth, anti-Anthropocene, fragility of balance, rejection of human exceptionalism, and ecological-crisis (Dunlap *et al.*, 2000).

Validating Construct Measures in Our Population. We did Confirmatory Factor Analysis (CFA) to validate the construct measures for science identity, self-efficacy, alignment with science values, sense of belonging, and environmental attitudes in our population. Using Mplus software, ver. 8 (Muthén and Muthén, 1998–2001, Los Angeles, CA, USA), we performed CFA analyses with request for modification indices. Two items were removed from the NEP scale due to poor fit with any latent variable. These items (NEP 4 and NEP 9) deal with rejecting human exceptionalism and performed poorly, perhaps due to the high number of religious students in our sample (Schultz *et al.*, 2000; Peterson, 2001; Miller *et al.*, 2006). All other items demonstrated acceptable fit with factor loadings above 0.5 with a few exceptions. Supplemental Figure S1 displays the measurement model with standardized correlation coefficients and factor loadings. Fit indices confirmed that the latent variables we intended to test were accurately represented by the final items included in analysis (TLI = 0.91, CFI = 0.92, RMSEA = 0.05, and SRMR = 0.05).

Quantitative Analysis

Data Reporting. Statistics were run using IBM SPSS Statistics (Version 29.0.0.0). For the independent samples t tests, data are mean ± SD, unless otherwise stated. There was always homogeneity of variances, as assessed by Levene's test for equality of variances, unless otherwise stated.

Multiple Linear Regression Assumptions. We tested the assumptions of multiple linear regression for each analysis reported in the results. There was linearity for each as assessed by partial regression plots and plots of studentized residuals against predicted values. There was independence of residuals for each outcome as well, as assessed by Durbin-Watson. There was homoscedasticity for each, as assessed by visual inspection of the plots of studentized residuals versus unstandardized predicted values. There was no evidence of multicollinearity in any regression, as assessed by tolerance values greater than 0.1. The assumption of normality was met for each, as assessed by Q-Q Plots. There were outliers (residuals greater than ± 3 standard deviations), but each was checked and assessed to be a valid-data point. When outliers were taken out, we arrived at the same conclusions, so outliers were left in.

Accounting for Nested Data. Our data were nested within sections, within classes, within instructors, within institutions, and within states. Differences between institution-type, state demographics, class topics, instructor practices, etc. would all likely impact the experiences of students, and NHPI students, specifically. Thus, we considered using linear-mixed models with random effects to account for this nesting, and all the differences that come with it, before testing the differences between NHPI and non-NHPI students. To check whether the random effects of section, class, instructor, institution, or state explained a large proportion of the variance in our outcome variables (pre-science identity, self-efficacy, science values, belonging, and NEP; change in science identity, self-efficacy, science values, belonging, and NEP), we calculated the intraclass correlation coefficient (ICC) for each random effect in an empty model (with no fixed effects) for each outcome variable (as described in Theobald, 2018). For the predata, we found that all ICCs were below 0.05, suggesting that grouping our data in these ways was not statistically meaningful for our outcome variables. Some random effects in our change data had an ICC that was above 0.05, with a maximum of 0.20, suggesting that data nesting may be meaningful when looking at changes over a semester. Next, we checked whether adding in random effects changed our conclusions about NHPI students. As suggested by Theobald (2018), we selected random effects in a full model (with relevant fixed effects) by comparing model fit of all combinations of random effects using the Akaike Information Criterion Corrected for small-sample sizes (AICC). For each outcome variable, we then chose the model with the combination of random effects that gave us the lowest AICC and compared the results of that model with the results of our statistical tests that did not account for nesting. Adding random effects created better models according to AICC but did not change our conclusions about NHPI versus non-NHPI students. Thus, we chose to report statistical results without considering random effects for simplicity.

Qualitative Analysis

Qualitative Analysis Procedure. Both surveys contained the free response question "How does your ethnic identity influence your science identity?" Pre- and post-survey responses to this question were read and coded. Three researchers (R.F.G., S.N., and J.G.A.) read open responses from NHPI students individually and noted common or interesting ideas. Next, the same researchers came together and compared their ideas to generate codes that reflected their findings. Some of our codes came from these inductive ideas, and others came from a priori ideas. These a priori codes included science identity, ethnic identity, NHPI culture, and Traditional Ecological Knowledge (i.e., diverse environmental knowledge, practices, and values commonly held by indigenous peoples; Kimmerer, 2002). Researchers (S.N. and J.G.A.) then coded all responses line by line using this initial codebook. If there was uncertainty for the meaning of the codes, they would meet and discuss as a group until they finalized and agreed upon the meaning of the codes. After everything was coded, researchers (R.F.G., S.N., and J.G.A.) met and discussed any differences until they came to a consensus with final codes (see Supplemental Table S1 for codebook). Finally, all three researchers looked at all the coded results together, reread responses that were coded similarly, and then as a team identified the major themes that are listed in the study.

Positionality Statement

Our team was composed of Mexican American (J.G.A.), Native Hawaiian/Tongan/white (G.E.K.A.), and white (R.F.G., S.N., and E.G.B.) researchers. Our academic experiences range from undergraduates (S.N. and J.G.A.), graduate student (R.F.G.), to faculty (E.G.B.: biology education, G.E.K.A.: Polynesian psychology). Three of us (S.N., R.F.G., and E.G.B.) have lived in Hawai‘i for extended periods of time (1–6 years) and have been connected to a university there, either attending (S.N.), teaching (E.G.B.), or both (R.F.G.). G.E.K.A. was born and raised in Hawai‘i. These connections have given us experience with and appreciation for many NHPI cultures, but this familiarity does not make us capable of understanding all NHPI students' experiences. Some of us have personally witnessed tensions between NHPI and Western cultures in Hawai‘i, so our bias may have led us to expect tension in NHPI-participant responses. Additionally, E.G.B. and R.F.G. have taught many NHPI students in science classes in Hawai‘i, so we have a particular interest in NHPI student belonging and success. Thus, we may be overly optimistic about the potential for the implications of our study to benefit these students. Alternatively, author J.G.A. has very little connection to NHPI culture. However, his experiences as a Mexican-American student allowed him to identify with responses that discussed marginalization or feeling like a minority in science. Thus, his background may have led him to emphasize these types of comments more often in the qualitative analysis. Given that author GEKA was born and raised in Hawai‘i and is of Native Hawaiian ancestry, bias from this author might have existed related to his personal experiences with the historical injustices and oppression of the native Hawaiian people, land, language, customs, and traditions. However, the team often met and revisited these potential biases to discuss their unique experiences and perspectives of the project. Because all members of the research team had specific strengths and biases related to their identities, it was important for us to consistently come back together and discuss our interpretations of the qualitative data. Thus, our method was very iterative and encouraged pushback from different research team members.

RESULTS

We collected quantitative survey data regarding students' Science identity, science self-efficacy, sense of belonging, environmental concern, strength of ethnic identity, the relationship between ethnic and science identities, and the intent to pursue a science career. We gathered data both at the beginning and end of a science course, allowing us to look at differences between NHPI and non-NHPI students upon course entry as well as how they were impacted by the course. Open-ended follow-up questions about the relationship between students' ethnic and science identities also provided qualitative data for a deeper look at NHPI students, specifically.

Presurvey Scores

To investigate whether NHPI and non-NHPI students are entering science courses differently, we compared presurvey scores for each construct using independent samples *t* tests and multiple-linear regression analyses. As shown in Table 2, NHPI students did not significantly differ from non-NHPI students in their precourse science identity, science self-efficacy, sense of belonging, or environmental concern (measured by NEP). Precourse science values scores may be significantly different for NHPI and non-NHPI students ($p = 0.05$), with non-NHPIs having higher science values prescores than NHPIs.

To see whether NHPI students were different from non-NHPI students after accounting for other demographics, and to validate our independent *t* test results, we ran a multiple-linear regression for each outcome variable (outcome ~ NHPI + Female + NHPI*Female + International + # HS Science classes + STEM major). We also investigated any interactions between gender and NHPI identity. We always included ethnicity, gender, interactions between ethnicity and gender (hereafter NHPI*female), nationality, number of science classes taken in high school, and identifying as a STEM major as predictors. A model with these predictors significantly predicted precourse science identity ($F[6, 707] = 41.712$, $p < 0.001$), science self-efficacy ($F[6, 694] = 14.347$, $p < 0.001$), science values ($F[6, 695] = 21.870$, $p < 0.001$), belonging ($F[6, 695] = 23.042$, $p < 0.001$), and environmental concern ($F[6, 694] = 13.298$, $p < 0.001$). Full regression results for each outcome can be found in Supplemental Table S2.

Based on the regression results (Supplemental Table S2), we found that neither NHPI nor NHPI*female was predictive of prescores for science identity, science self-efficacy, belonging, or environmental concern. This indicates that NHPI and non-NHPI students are not entering Biology courses differently in terms of their science identity, science self-efficacy, belonging, or environmental concern, and there is no interaction between their ethnicity and their gender regarding these variables. Prescores for science values remained close to significant ($p = 0.05$) after accounting for nesting, suggesting that there may be a difference in science values for NHPI and non-NHPI students when they enter a biology course.

Though NHPI and NHPI*female did not significantly predict any of our outcomes, some of our predictors were significantly related to the precourse variables. Science identity was positively predicted by the number of science classes taken in high school ($p < 0.001$) and STEM major ($p = 0.002$). Science self-efficacy was positively predicted by gender ($p < 0.001$), the number of science classes taken in high school ($p = 0.006$), and STEM major ($p < 0.001$). As the literature predicts, women report lower self-efficacy than men, but NHPI women are not different from non-NHPI women in terms of precourse science self-efficacy ($p = 0.714$). Alignment with science values was positively predicted by STEM major ($p < 0.001$). Belonging was positively predicted by STEM major ($p < 0.001$). Environmental concern (measured by NEP) was positively predicted by gender ($p < 0.001$) and STEM major ($p < 0.001$). Females had pre-NEP scores that were 2.787 points higher than men, on average ($p < 0.001$). All regression coefficients and standard errors can be found in Supplemental Table S2.

Additionally, we examined only NHPI students and asked whether the degree to which they identified with their ethnic identity (measured by MEIM-R) correlated with any of our presurvey measures. NHPI students' MEIM-R scores were not correlated with precourse science identity ($r = 0.05$, $p = 0.69$, $n = 70$), self-efficacy ($r = 0.11$, $p = 0.38$, $n = 68$), science values ($r = 0.14$, $p = 0.27$, $n = 68$), belonging ($r = 0.11$, $p = 0.40$, $n = 68$), environmental concern ($r = 0.12$, $p = 0.33$, $n = 68$), or intent to pursue a science career ($r = -0.14$, $p = 0.26$, $n = 68$).

We ran a Mann-Whitney *U* test to determine whether there were differences in perceived impact of ethnic identity on science identity between NHPIs and non-NHPIs at the beginning of the semester. While the median response for both NHPIs and

TABLE 2. Independent Samples *t* Tests Results for Presurveys and Change in Survey Scores

Variable		non-NHPI	NHPI	*t* statistic	*p* value
Science identity	Prescore	17.22 ± 3.83; *n* = 650	17.07 ± 3.97; *n* = 70	t(718) = 0.32	*p* = 0.75
	Change[†]	0.43 ± 5.90; *n* = 459	1.79 ± 7.31; *n* = 38	t(495) = –1.34	*p* = 0.18
Self-efficacy	Prescore	19.81 ± 4.03; *n* = 639	18.90 ± 4.69; *n* = 68	t(705) = 1.75	*p* = 0.08
	Change	0.64 ± 5.89; *n* = 452	0.67 ± 7.00; *n* = 36	t(486) = –0.03	*p* = 0.98
Science values	Prescore	16.21 ± 3.36; *n* = 640	15.35 ± 3.73; *n* = 68	t(706) = 1.98	*p* = 0.05
	Change	0.68 ± 4.61; *n* = 454	1.92 ± 5.29; *n* = 36	t(488) = –1.53	*p* = 0.13
Belonging	Prescore	26.10 ± 4.19; *n* = 640	25.28 ± 4.56; *n* = 68	t(706) = 1.53	*p* = 0.13
	Change	0.36 ± 6.14; *n* = 453	1.08 ± 7.84; *n* = 36	t(38.491) = –0.54[‡]	*p* = 0.59
Environmental concern (NEP)	Prescore	26.86 ± 4.95; *n* = 639	27.41 ± 3.96; *n* = 68	t(90.85) = –1.07	*p* = 0.29
	Change	0.96 ± 7.52; *n* = 452	0.36 ± 7.06; *n* = 36	t(486) = 0.46	*p* = 0.64

[†]Change is calculated as postscore minus prescore.
[‡]Due to a lack of homogeneity of variances, as assessed by Levene's test for equality of variances, we ran a Welch's *t* test for the construct of belonging.

non-NHPIs was 0 (no relationship), the distributions were significantly different by Mann-Whitney *U* test ($U = 25476.50$, $z = 2.381$, $p = 0.02$). On average, NHPIs reported their ethnic identity as more strengthening to their science identity (mean = 0.27 ± 0.92) than did non-NHPIs (mean = 0.13 ± 0.53) as shown in Figure 1. In addition, a one-sample Wilcoxon Signed Rank Test showed that NHPI students' median response was significantly higher than zero ($z = 2.31$, $p = 0.02$).

We also asked the question "To what extent do you intend to pursue a science-related research career?" This item had respondents rate their likelihood of pursuing a science-related career on a scale of 0 (definitely will not) to 10 (definitely will).

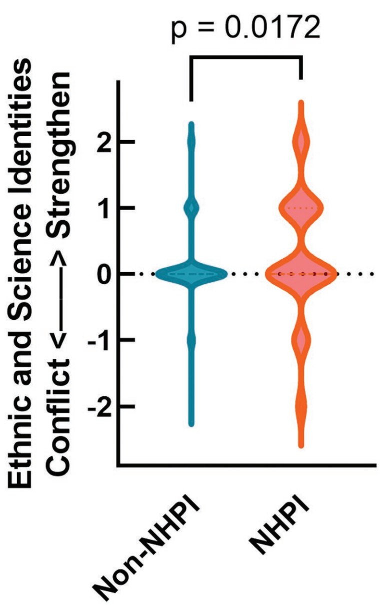

FIGURE 1. NHPI students report a more strengthening relationship between their ethnic and science identities than do non-NHPI students. Data are from a Likert-style survey question on the presurvey about the relationship between ethnic and science identities. Conflicts a lot = –2; conflicts a little = –1; has no relationship = 0, strengthens a little = 1, strengthens a lot = 2. Violin plot shows frequencies of responses. Difference between NHPI and non-NHPI students is significant by Mann-Whitney *U* test.

A Mann-Whitney *U* test was run to determine differences between NHPI and non-NHPI students' intent to pursue a science career at the beginning of the semester. Distributions of intent to pursue science prescores were similar for NHPI (median = 3.5) and non-NHPI (median = 3.0) students ($U = 23583.0$, $z = 1.170$, $p = 0.242$).

Change in Scores over a Semester

To investigate whether NHPI and non-NHPI students are being impacted by science courses differently, we calculated a change score (postscore minus prescore) for each construct. We then compared these change scores for NHPI versus non-NHPI students using independent samples *t* tests and multiple-linear regression analyses. As shown in Table 2, NHPI students were not significantly different from non-NHPI students in terms of their change in science identity, self-efficacy, science values, belonging, or environmental concern (measured by NEP) after a semester in a biology course.

To see whether NHPI students were different from non-NHPI students after accounting for other demographics, and to validate our independent *t* test results, we ran a multiple-linear regression for each outcome variable (outcome ~ NHPI + Female + NHPI*Female + International + # HS Science classes + STEM major). A model with these predictors significantly predicted changes in science identity ($F[6, 484] = 13.839$, $p < 0.001$), science self-efficacy ($F[6, 475] = 4.155$, $p < 0.001$), science values ($F[6, 477] = 12.773$, $p < 0.001$), belonging ($F[6, 476] = 8.353$, $p < 0.001$), and environmental concern ($F[6, 475] = 4.274$, $p < 0.001$). Full regression results are found in Supplemental Table S3.

Based on these regression analyses, change in science identity, science self-efficacy, science values, belonging, and environmental concern was not significantly predicted by NHPI nor by an interaction between NHPI and gender. This indicates that NHPI and non-NHPI students are not being impacted differently by science courses in terms of their science identity, science self-efficacy, science values, belonging, or environmental concern due to their ethnicity or due to any interaction between their ethnicity and their gender.

Though NHPI and NHPI*female did not positively predict any of our outcomes, some of our outcomes were positively predicted by other predictors in our model. Change in science identity was positively predicted by the number of science classes taken in high school ($p = 0.004$) and STEM major ($p < 0.001$). Change in self-efficacy was positively predicted by gender ($p = 0.011$) and STEM major ($p < 0.001$). Women made more gains in their self-efficacy scores over the course of the semester than men (B = 1.378), but NHPI women are not different from non-NHPI women in terms of precourse science self-efficacy ($p = 0.436$). Change in science values was positively predicted by the number of science classes taken in high school ($p = 0.014$) and STEM major ($p < 0.001$). Change in belonging was positively predicted by the number of Science classes taken in high school ($p = 0.042$) and STEM major ($p < 0.001$). Change in environmental concern (measured by NEP) was positively predicted by gender ($p < 0.001$) and STEM major ($p = 0.017$). Females decreased in NEP scores by 2.992 points more than men over the course of a semester, on average ($p < 0.001$). All regression coefficients and standard errors can be found in Supplemental Table S3.

We also examined NHPI students alone and asked whether the degree to which they identified with their ethnic identity (measured by MEIM-R) correlated with any of our change measures. NHPI students' MEIM-R scores were not correlated with their change in science identity ($r = –0.02$, $p = 0.92$, $n = 38$), self-efficacy ($r = 0.12$, $p = 0.51$, $n = 36$), science values ($r = 0.00$, $p = 0.99$, $n = 36$), belonging ($r = –0.02$, $p = 0.93$, $n = 36$), environmental concern ($r = –0.21$, $p = 0.21$, $n = 36$), or intent to pursue a science career ($r = 0.16$, $p = 0.35$, $n = 36$).

When we compare their change in perceived impact of ethnic identity on science identity (postscore–prescore), we find that there is no evidence of NHPIs being significantly different from non-NHPIs in terms of change. The median impact of ethnic identity on science identity score for NHPIs (0.00) and non-NHPIs (0.00) was not statistically significantly different, $U = 7788.50$, $z = –1.314$, $p = 0.189$. Therefore, we did not find evidence that NHPI and non-NHPI students' perceptions of the intersection between their ethnic identity and science identity are being affected by science courses differently.

We ran a Mann-Whitney U test to determine differences between the change in NHPI and non-NHPI students' intent to pursue a science career over the semester. Distributions were similar, and there was no statistically significant difference in median intent to pursue a science career change scores between NHPIs (0.00) and non-NHPIs (0.00; $U = 8321.50$, $z = 0.208$, $p = 0.835$).

A Closer Look at the Relationship Between Ethnic and Science Identity

We conducted thematic analysis on student's open response answers to the question "How does your ethnic identity influence your science identity" and found four major themes. These were: 1) identities are separate, 2) cultural values and science, 3) representation, and 4) relationship with the environment. Table 3 shows how many students are represented by each theme, whether their answer reflected a neutral, positive, or negative interaction, and an example quote. Every student included in our thematic analysis identified as NHPI in demographic data. Student responses were aggregated from the pre- and postsurvey responses, so quotes could come from either survey.

Identities are Separate. The most common theme mentioned by students (30/70) was that their ethnic and science identities had no relationship. Students said things such as "I really don't see the connection. Anybody can be good at science if they choose to develop themselves in it"; "Two separate identities… The two are not related. One is by choice, and one is not by choice"; "I think your preference for science depends on your own individual interests not your culture"; and "The fact that I am white and Pacific Islander has no ties to my science identity. I do not correlate them at all". Explanations like these were typical and demonstrated these students saw no relationship between their ethnic and science identities.

However, we identified an important subtheme under the theme of identities being separate–some students (5/70) were choosing to *intentionally* separate their ethnic and science identities. We interpreted this to mean there was conflict between the two identities, so to mitigate that conflict students kept their ethnic and science identities apart from each other. Although these students indicated there was "no relationship" between their ethnic and science identities on the Likert-scale question, their explanations as to why there was no relationship between these identities differed from the 30 other students who expressed the identities were unrelated. For example, Table 3 quotes a student that explicitly discusses putting on different "hats" depending on who they are around. They wear a "science hat" when they are around those who will listen/understand, and they take off their science hat when around others who may not understand science. Similar feelings were expressed by others, with one student stating that "I don't associate my science identity with my ethnicity at all. I keep them separate."

This awareness of potential conflict between ethnic and science identities and therefore needing to separate them was more apparent in some student responses than others. One student said, "There are some disagreements between science and culture. But I just don't bring my culture into science. I wanted to learn science as it is." Another student also discussed this conflict between their cultural/traditional beliefs and science: "When it comes to cultural and traditional beliefs those sometimes interfere with modern ethics or practices. It just depends on the individual and their beliefs. For myself personally I don't let it affect me." The student expresses an awareness of conflict between their culture and science, but they choose to not let this conflict affect them. This theme of keeping identities separate intentionally demonstrates that if students perceive conflicts between their science and ethnic identities, they may mitigate this conflict by intentionally separating these identities.

Cultural Values and Science. The second most discussed theme by students (27/70) was the relationship between cultural values and science. Students indicated that their cultural values came from a variety of sources, including their communities, personal experiences, teachings, and traditions. Most students who mentioned their cultural values' relationship with science indicated a strengthening interaction, but not all. Nine students expressed conflict between their cultural values and science, demonstrating diversity amongst NHPI students in terms of how they perceive their cultural values relate to the values of the scientific community. Students who felt conflict between their cultural values and science often discussed how

TABLE 3. Themes Found in NHPI Student Responses and How Students Reported Their Ethnic and Science Identity Interacted

Theme/Subthemes	Relationship Between Identities	Number of Students Represented†	Example Quote
Identities are separate			
No relationship—Identities perceived to be unrelated	No relationship	30	"I don't see a conflict or strengthening between who I am ethnically and scientifically…I don't see them as opposing or strengthening each other, they are just both part of who I am and what makes me."
Identities intentionally separated	No relationship/ Conflicting	5	"My two identities exist on [their] own. I put on my science hat when I'm among those who will listen and take it off when those who will not listen and rather speak of the magic behind the world around me."
Cultural values and science			
Contradictions between accepted cultural beliefs and scientific beliefs	Conflicting	9	"A big issue that recently occurred was the establishment of telescopes on Mauna Kea, a sacred mountain located on the Big Island. While many people have funded this project and intend to build telescopes on there, many native Hawaiians don't agree with this and see it as a desecration of values, beliefs, and an invasion of our homeland."
Strengthening of cultural background	Strengthening	23	"As a Native Hawaiian, I feel like my view and identity is strengthened here in Hawai'i. As, issues, like TMT, invasive species, medicine, etc. All come into contact with the community around me. So, I feel like being a Native Hawaiian strengthens my identity as a scientist because it connects me with Hawai'i as a whole."
Representation			
Representation of ethnic community	Conflicting	2	"I would say that my ethnic background influences my science identity because it is very rare that you see someone of my ethnic background (Samoan) in the field of science."
	No relationship	2	"There are not many Polynesians in the field of science, granted, but I more see my science identity as stemming from my own feelings, interests, and background outside of ethnicity. Simply put, I don't feel the way I do about science just because I'm Polynesian."
	Strengthening	6	"I think that as a student who aspires to become a healthcare professional, knowing that there isn't a lot of Polynesian representation in the medical community helps motivate me to further my education and be that representative."
Desire to help ethnic community	Strengthening	2	"I come [from] a very small island where the hospital is not very good at handling problems and dealing with patients. A lot of families have sorrow and [are not] satisfied with what is going on with the doctors and nurses can't do better in healing patients. So, knowing and [having] experienced it in Tonga, I want to come and study science so I could go back and help my people. Everything in Tonga has a part in science and I will for sure that one day I'll help my people in a way they could be satisfied with their needs."
Relationship with environment	Strengthening	6	"Because my Polynesian culture connects my people a lot with the earth, I think biology in particular has a close tie with my ethnicity. Respecting the earth makes me want to learn more about it."

†Total $n = 70$

science refutes common cultural traditions, feelings, and/or beliefs they had been taught by their families and communities. This led to them feeling that their cultural values did not align with what was being taught in their science classes. One student marked their ethnic identity conflicted a little (–1) with their science identity and explained: "My Native Hawaiian background is rich with beliefs that contradict the facts that Modern Science has proven." Another student indicated that their ethnicity conflicted a lot (–2) with their science identity, explaining: "My country is very religious and anything that conflicts with Christian beliefs is not permitted to enter the Cook Islands." Another example is seen in the quote from Table 3, wherein the student discusses conflict between their Hawaiian culture and scientific research projects that threaten places they hold sacred.

Although there were some students that expressed conflict between their cultural values and science, there were more students (23/70) that said the relationship between the two was strengthening. Some students attributed this positive relationship to science helping them better understand their cultural/ethnic background (e.g., “Through science research, I am able to know more about my culture!”). Others described already seeing science within their culture. For example, one student said “Yes, I believe that my ethnic identity influences my science identity greatly because in my Hawaiian culture, science is applied to everything. Science is applied to star navigation, although my ancestors used noninstrumental navigation and way-finding;” a second student said, “My mom was born and raised in Hawaiʻi. Hawaiʻi is a very biodiverse island and the native people are aware of it and try to preserve that biodiversity as best they can.” Others felt that including their culture in science benefited science itself and thereby fostered a positive relationship. As one student explained, “In the case of Hawaiians in Hawaiʻi, I feel like the cultural lens enhances the scientific method because it can take more variables, or data inputs, into account that would otherwise go unrecognized. It simply provides more depth and significance to findings.” Students also discussed how this strengthening interaction goes both ways. Science increases their understanding of their culture, and their cultural knowledge also increases their scientific understanding. Additionally, students expressed that when their scientific study involves aspects of their culture, it becomes more interesting to them because they can personally apply it to their own life.

Representation. The third most common theme was representation (10/70 students). There was diversity in how students were impacted by the representation of their ethnic group in science. In our analysis, we defined “community” as people of the same cultural background or ethnic identity. Students frequently mentioned not seeing members of their community in STEM and subsequently feeling unrepresented. For two students, this negatively affected their science identity (“conflicted a little” on the Likert question). The first student explained, “I would say that my ethnic background influences my science identity because it is very rare that you see someone of my ethnic background (Samoan) in the field of science.” The second student said, “I don’t feel like I know that many other Pacific Islander scientists or it’s just not a popular job in that community.” These students indicated that a lack of representation caused them to feel conflict between their ethnic and science identities.

However, most students who discussed representation of their ethnic group (6/10) indicated that there was a strengthening relationship between their ethnic and science identities. One student marked “strengthened a little,” then explained: “Not a lot of Polynesians are in the medical field, but a lot of Caucasians are. There are pros and cons to this." We coded this response as both a positive and negative relationship between ethnicity and Science identity, due to them citing pros and cons, though they did not elaborate what these were. Another student who indicated a strengthening relationship between their ethnic and science identities said: “My Hawaiian culture depends on the studies of science and we work our natural systems based on nature and the things of science. However, there aren’t many Polynesians in the field of science.” It is unclear, but it seems the student’s science identity is strengthened because of the ties their Hawaiian culture has with natural systems, despite there not being many Polynesians in the field of science. This suggests that students who feel their cultural values align with science values may feel a strengthening relationship between the two, even if they feel underrepresented. Other students mentioned feeling inspired by others from their community who they saw in science. This shows that representation can work both ways. One student said, “Strengthens a little because I have relatives whose courses are nursing.” Another student said, “I have a lot of respect for non-Caucasian scientists and recognize every scientist’s contribution.” Finally, some students felt their people have always been scientists, indicating a broader definition of the word “scientist.” For example, one student said, “In Hawaiʻi, the people have always been scientists, explorers, and navigators,” indicating that they see science represented in their culture, even if it is not included in the standard definition of science. This student also indicated a strengthening relationship between their ethnic and science identities.

There were also some students (2/70) who expressed a desire to help their ethnic community, citing a lack of representation as a problem they could help solve. The quote in Table 3 exemplifies this subtheme, wherein the student discusses how a lack of good healthcare on their home-island inspired them to study science so they could help their people. Another student said: “I study exercise sports science and my future goal is to somehow use the knowledge that I have gained over the years to somehow help my people choose better, healthier lifestyles.”

Relationship with the Environment. The final theme we saw in our analysis was “relationship with the environment.” Six students mentioned strong cultural ties to the land and environment, indicating that their connection with the environment came from their cultural/ethnic identities. All but one of these students indicated that their ethnic identity influenced their science identity in a strengthening way. The student who felt their ethnic and science identities conflicted a lot said:

> My country is diverse and we have different culture and beliefs and most of them are basic science and people deal with daily life and talk more about it. We have so many different species of plants that are unique and you can’t even find them in any other places around the world.

The remaining five students expressed a positive relationship between their Polynesian culture and their desire to learn about or protect the earth, which in turn impacted their science identity. One student said: “As a researcher in the field of marine biology, the Polynesian culture is very strengthening seeing as our people care to protect our Oceans and our way of life.” Another said, “Hawaiian culture thrives on biology and nature, as the land is part of our identity.” Thus, NHPI students’ science identities were seen to be strengthened by their ethnic identities as they made connections between their ethnicity/culture and science.

DISCUSSION

We found that NHPI students, although underrepresented in the sciences, are not significantly different from their non-NHPI peers in terms of the three facets of social-influence theory (science identity, self-efficacy, and alignment with science values; see Table 2). We also did not find evidence of an interaction between ethnicity and gender influencing these predictors (see Supplemental Table S2). This contrasts with previous studies that found differences in these predictors based on ethnicity and interactions between ethnicity and gender, particularly in Black and Hispanic populations (Carlone and Johnson, 2007; Gibbs Jr *et al.*, 2014; Hill *et al.*, 2018; Robinson *et al.*, 2018; Byars-Winston and Rogers, 2019; White *et al.*, 2019; Ackert *et al.*, 2021). However, NHPI students reported lower alignment with science values at the beginning of the semester than non-NHPI students, though this finding was insignificant (p = 0.05). While the four items in the science values instrument did load together in our CFA (see Supplemental Figure S1), future validity research could look more closely at how NHPI students interpret the items on the science values scale. A larger sample size of NHPI students could also help us determine whether there is a significant difference between NHPI and non-NHPI students in terms of alignment with science values. Additionally, we did not see significant differences between NHPI and non-NHPI students in terms of their change in scores over the course of a semester (see Table 2). This suggests that science courses are not differentially influencing NHPIs' science identity, self-efficacy, or alignment with science values, and potential differences between NHPI and non-NHPI students may be more impacted by factors preceding their entry into these courses. Furthermore, as we focused on Science identity, specifically, our quantitative and qualitative results suggested that the relationship between NHPI students' ERI and their science identities is complex.

As Estrada *et al.* (2011) discusses, belonging is an important contributor to the development of science identity. We had hypothesized that NHPI students could have higher levels of environmental concern, and thus feel greater belonging in science. This was not supported by our quantitative data, as we saw no significant difference between NHPI and non-NHPI students in terms of environmental concern or belonging (Table 2). However, when students were asked to write about the interaction between their ethnic and science identities, we saw that it is more complicated than what our quantitative findings show. While students did not specifically use the term "belonging," they did allude to it. For example, some NHPI students ranked their ethnicity as conflicting with their science identity, then gave the reason that they do not see others like them in science. This could imply that they do not feel like they belong. However, we also found that some NHPI students use the underrepresentation of their ethnic/racial group as a source of motivation to persist in the field, which is consistent with previous findings for African-American students (Johnson, 2016) and Latina students (Sparks *et al.*, 2021). This is reminiscent of the resistant capital discussed as part of Yosso's (2005) Community Cultural Wealth theory, which suggests that skills gained through confronting marginalization can benefit People of Color as they navigate inequitable education systems.

Other NHPI students indicated a strengthening relationship between their ethnicity and their science identity because they saw their people as scientists (e.g., wayfinders), or because their community wants to see them succeed in science. This could be an example of familial capital in Community Cultural Wealth theory, wherein community history and memory can help bolster People of Color in exclusionary educational contexts (Yosso, 2005; Acevedo and Solorzano, 2021). Future research could investigate the role this familial capital plays in the belonging and science identity development of NHPI students. In addition, NHPI students frequently drew on cultural connections to the environment when discussing how their ethnicity interacted with their science identity. Thus, highlighting science values that are connected to the environment could be beneficial in strengthening NHPI students' science identities and could bolster their sense of belonging in science.

Another way we dove deeper into science identity was by explicitly asking students about the relationship between their ethnic and science identities. Almost half (48.6%; n = 70) of NHPI students and more than half (80.3%; n = 646) of non-NHPI students marked that there was no relationship between their ethnic and science identities on a Likert-style question at the beginning of the semester (see Figure 1). Of those who did report a relationship, more NHPI students chose strengthening than conflicting (consistent with Sumabat Estrada, 2020; Chen *et al.*, 2021). However, the degree to which NHPI students identify with and are committed to their ethnic identity (measured using the MEIM-R) was not correlated with the strengthening effect their ethnic identity can have on their science identity. Thus, our data suggest that when NHPI students even weakly identify with their ethnic identity, they may experience a strengthening effect on their science identity. Even so, our qualitative data also highlight that this relationship is complex and that even a single student can experience both strengthening and conflicting relationships between their ethnic and science identities (consistent with Tran, 2011; Morton and Parsons, 2018; Rosa, 2018; Nhien, 2022).

Our findings are consistent with Carlone and Johnson's (2007) findings wherein they reported marginalized students exhibiting three types of science identities: 1) research, 2) altruistic, and 3) disrupted. We did not see much evidence for "research science identities," but it could be that our specific questions were more likely to draw out information about altruistic and disrupted science identities. Most predominantly, we saw NHPI students exhibit "altruistic science identities," wherein they redefine what science means and use science as a tool to accomplish their goals of helping others. This was seen in students saying that they wanted to pursue science so they could help their families, communities, islands, and the environment. Multiple NHPI students cited science as a method by which they could help protect the environment and the ocean, or things that were important to them and their culture. Some discussed how their people have always been "scientists," citing wayfinding and other navigation as examples. They extended the definition of science to incorporate their culture and what they viewed to be science. This could also be another example of NHPI students acknowledging and accessing their Community Cultural Wealth to help them navigate the field of science (Yosso, 2005).

Finally, we saw Carlone and Johnson's (2007) "disrupted science identities" in NHPI students. This was most obvious in the students who wanted to keep their ethnic and science identities separate intentionally. They were aware of their ethnicity's underrepresentation or marginalization in science, so they tried to separate that aspect of themself away from science and their science identity. This could indicate an acknowledgment or fear of potential conflict between the two. Tran (2011) also found that students "wear multiple hats" to manage different identities for different contexts and situations, which is what some of our students reported doing. Other students explicitly discussed feelings of conflict between their ethnic and science identities, which were reminiscent of barriers addressed in the literature, such as alienation, hidden racism, systemic inequities, isolation (Lett and Wright, 2003; Espinosa, 2011; Leggon, 2011; McGee, 2016; Miriti, 2020), and cultural barriers specific to NHPI students (Kerr *et al.*, 2018).

In conclusion, we did not find evidence of NHPI and non-NHPI students differing in their science identity, self-efficacy, or alignment with science values. We did see hints that NHPI students may have lower alignment with science values upon course entry, but we do not have evidence that they are impacted by a science course differently than their non-NHPI peers. When we looked closer at the aspect of identity, our investigation of sense of belonging and environmental concern also did not return significant differences between NHPI and non-NHPI students. However, when asking students outright what impact they felt their ethnic identity had on their science identity, NHPI students reported more strengthening relationships between the two on average than non-NHPI students. Additionally, this was significantly different from zero. Again, this was *on average,* meaning that there were still NHPI students that felt no relationship or that felt conflict between their ethnic and science identities. The breadth of NHPI student views became clearer with the free-response data we analyzed, wherein we found that even individual students can express feelings of both conflict and support between their ethnic and science identities. The relationships between these identities are complex and may be more influenced by precollege experiences than classroom experiences, but instructors should still be aware of and address potential feelings of conflict while also bolstering the supporting aspect of these relationships for NHPI students.

Limitations and Future Research

The quantitative portion of our study was inherently limited due to the low numbers of NHPI students that we were able to recruit to take the survey. Thus, we did not have the statistical power to detect small differences between NHPI and non-NHPI students. For example, the close-to-significant difference seen in terms of alignment with science values at the beginning of the semester could be a real difference that could be validated with larger samples. Furthermore, survey instruments for science identity, self-efficacy, and alignment with science values cannot necessarily capture the complexities of these constructs. In addition, while we confirmed that the survey items loaded together in our population using CFA, think-aloud interviews with NHPI students could be beneficial to better understand how they interpret these items and whether the "science values" assumed in these instruments are welcoming to all groups. As another limitation to our data, our quantitative data about the interaction between science identity and ethnic identity was based on a single question. However, we used an open-response follow-up question to collect more information about this construct. Future research could develop a more expansive instrument to test the impact ERI has on science identity.

Our findings are also limited due to the composition of our sample. Our surveys were rather lengthy, so it is possible that students with the strongest investment in science would be most likely to take and finish the surveys. Furthermore, first- and second-year students are the most represented, as shown in Table 1. Upperclassmen are likely to have different experiences, and we might have gotten different results with more upperclassmen in our sample. In addition to this, the biology classes we surveyed were likely very different from one another due to instructor, institution, and state differences. We also did not gather data about their content coverage or pedagogy. Furthermore, NHPI students at minority-serving institutions would likely have different experiences than those at primarily white institutions. However, including random effects for state, institution, instructor, and class in our mixed models would account for variance due to these differences, and accounting for this nesting did not impact our results (see *Methods*). Thus, we cannot comment on the impacts of specific course characteristics, but these lurking variables did not change our results. Future research could be done to see how different types of classes impact NHPI students longitudinally. Additionally, we may not have seen significant longitudinal changes in student responses because we only sampled over one semester. There may be more significant longitudinal changes as students go from lower to upper classes. It is also important to note that the NHPI students that did persist in science long enough to participate in our study could be a unique group of students that are not representative of all NHPI students. Further studies could investigate NHPI students at earlier stages in their experiences with science.

Finally, some of the institutions included in this study share a religious context. This could have impacted our results, as we saw with the two NEP items regarding human exceptionalism needing to be excluded from analysis due to poor loading in our model (see *Methods*). This aligns with previous studies that have found differences in environmental concern amongst religious groups (Schultz *et al.*, 2000; Brehm and Eisenhauer, 2006). Future research could see whether our NEP results are applicable in broader groups.

Implications

Instructors should be aware of potential conflicts between students' ethnic and science identities and respond to them sensitively when they arise. For example, the threat of development on Mauna Kea in Hawaiʻi created conflict between some students' ethnic and science identities. In instances like these, instructors should be culturally competent (Ladson-Billings, 1995a,b, 2016; A. Johnson and Elliott, 2020) when discussing the interaction of ethnicity/culture and science, as some students may have identities that feel at odds. While instances like these exist and should be navigated carefully, instructors should also realize that NHPI students' ethnic identities can be leveraged as a mechanism to strengthen their science identities, as many students already see it this way.

Instead of seeing underrepresented groups through a deficit model, we must acknowledge the community cultural wealth (Yosso, 2005) that they are already bringing to the scientific community. We saw our NHPI students being strengthened by their cultural heritage and knowledge from past generations to help them identify as scientists, consistent with the Community Cultural Wealth framework (Yosso, 2005). This aligns with recent shifts in the literature that advocate for the system to change to recognize this community cultural wealth that students bring to science (Lett and Wright, 2003; Montgomery, 2020a). Though it may not always be simple to do this, there are many methods that have been proposed to acknowledge students' culture in the classroom (such as the inclusion of Traditional Ecological Knowledge in science classes), with suggestions on how to thoughtfully do so available (as reviewed in Greenall and Bailey, 2022). Most importantly, we found that NHPI students often see their ethnic identity as a strength in science–-we should too.

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