MODESTUM

Research Article

OPEN ACCESS

A scoping review of the intersection of environmental and science identity

Susan Caplow [1]* , Roberta Hunter [2]

[1] University of St. Thomas, St. Paul, MN, USA

[2] New Jersey Audubon, Bernardsville, NJ, USA

*Corresponding Author: scaplow@stthomas.edu

ARTICLE INFO	ABSTRACT
	As our environmental problems continue to mount, we need a committed, diverse community of citizens and scientists across disciplines and sectors who have the skills and passion to develop creative and novel solutions to our most challenging environmental problems. Previous literature in environmental identity and science identity suggests that encouraging identity development in each of these areas during education programs could help grow both the number and diversity of environmentally-minded scientists and citizens. However, despite the importance and theoretical overlap of these two areas of identity research, very little data has been collected simultaneously on these constructs. Our scoping review describes the limited number of studies that empirically examine both environmental and science identities, exploring key thematic areas of overlap related to diversity, methods, educational programming, and identity theory. Based on a combination of these studies and other key literature in environmental and science identity research, we propose a mixed-method instrument that could be used to measure the development and presentation of environmental/science identity, so that we can better understand the relationship between the two constructs at the individual and collective levels. **Keywords:** environmental identity, science identity, scoping review, instruments, data collection methods

INTRODUCTION

The anthropocene requires more scientists (doers of science) and citizens (users of science) who are prepared to address emerging and complex environmental and scientific challenges (Clayton, 2003; Tugurian & Carrier, 2017). Previous research has argued that the development of science identity (SCID) or environmental identity (EID) can encourage individuals to develop skills, interests, and passions in environmental problem-solving (Blustein et al., 1989; Olivos & Aragonés, 2011; Shinbrot et al., 2022). In particular, a strong identity association in these two areas is important because strong identifying tendencies are associated with targeted career outcomes, cognitive/emotional development, and the development of environmental care (Carrier et al., 2013). Additionally, education is a key mechanism to encourage the development of both an interest in science and an interest in nature, yet science and nature are not always clearly connected for students in the classroom (Cobern et al., 1999; Tugurian & Carrier, 2017). These processes are particularly salient for learners in K-12 and college, a time when a great deal of personal, professional, and citizenship development occur. Helping learners develop identities as doers or users of science can prepare them to use scientific information in making decisions about the environment and taking action, which is an outcome of a strong EID.

Identity is also an important feature of this landscape because of the current relationship between science and other identities. In this time of great need for scientific inquiry, levels of trust in science are in decline (Funk, 2017; Rynes et al., 2018). In particular, science is seen as a threat to some social identities (Nauroth et al., 2015; Wynne, 2016) and the disciplinary siloing of scientific identities can limit the scientific community's ability to consider broader environmental and social impacts of decision-making (Stirling, 2014). Additionally, we know that both scientists and citizens tend to value/express interest in science that validates our own identities and promotes solutions in which we have an interest (Morton et al., 2006). Thus, we need a population that views the pursuit of scientific environmental problem-solving as an identity-affirming endeavor.

In this paper, we describe existing literature at the intersection of EID and SCID by identifying and exploring content within emergent themes of diversity, educational programming, methods, and identity theory. We then collect and curate existing survey and interview questions from each area of research to propose data collection tools that could be used in future research to simultaneously explore EID and

SCID. This information can help practitioners and researchers better understand how both types of identities are affected by and developed through educational interventions, and how these changes might affect environmental and science-related outcomes.

What is Identity?

Identity can be roughly described as how one sees oneself in relation to others and the world around us–one's response to the question "Who am I?" (Vignoles et al., 2011). Identity theory is not monolithic, but there are a few key ways scholars have envisioned identity. According to Stets and Burke, most scholars describe identity as either being synonymous with culture, membership to a social category, or as "parts of a self composed of the meanings that persons attach to the multiple roles they typically play in highly differentiated contemporary societies" (Stets & Burke, 2000, p. 284). In other words, identity has a social and an internal/cognitive component, both central to Mead's (1934) foundational work in identity but often explored separately by scholars (Burke & Stryker, 2016; Hogg et al., 1995). Within internal and external worlds, all individuals hold multiple and intersecting identities at one time - professional identities such as a student or researcher; social identities such as a Democrat, parent, Taylor Swift fan, or an environmental activist; and cultural and ethnic identities such as South Asian or Francophone. While identity is somewhat stable over time, there is a constant and evolving mediation process between the self, other people, and their environment (Marcia, 1980; Stapleton, 2015). There is also a narrative component to identity, as it is reinforced by the stories we tell ourselves and others tell about us (Holland et al., 2001).

While scholars continue to dispute finer points of identity theory, identity remains a powerful concept in social science, largely because of its power in shaping lives. A variety of empirical studies have found that identity features greatly influence life decisions, such as schooling, career, leisure, and relationship within and without membership groups (Blustein et al., 1989; Grotevant, 1987; Vignoles et al., 2011). Educational experiences also impact identity development, partly because they tend to occur in adolescence, when identity formation is a central aspect of overall development (Amiot et al., 2007; Grotevant, 1987), and partly because an educational intervention can teach skills, values, and pathways associated with certain identities (Prévot et al., 2018; Verhoeven et al., 2019). In the latter case, identity presentation in education programs has been explored as a key mechanism to increase diversity in various professional fields, as the cultural image of who is a scientist, lawyer, doctor, etc., has reinforced social and cognitive barriers to minoritized groups and women in particular (Carlone & Johnson, 2007; Capobianco, 2006; Jacobs, 1971; Kim-Prieto et al., 2013).

Identity has been a frequent area of inquiry in education research, both in terms of how educational settings can help develop students' identities (e.g., Kaplan & Flum, 2012; Veerhoven et al., 2018) and how the intersecting identities students bring with them affect learning in multiple settings (e.g., Altugan, 2015; Falk, 2016). Types of identity that have been studied in regards to their intersection with learning in in and out of school include racial and ethnic identity (e.g., Battey & Leyva, 2016; Giampapa, 2010; Stevenson et al., 2019), gender identity (e.g., Barton et al., 2013) and sexuality (e.g., Watson, 2005). Educators and researchers are interested in supporting students in developing disciplinary identities related to their content area, such as reading and writing (e.g., McCarthey, 2001), math (e.g., Berry et al., 2011), and science, which is explored in more depth below.

In this paper, we focus on two identities that have exceptional potential to help us address our environmental crisis, EID and SCID. While we make no claims that these two identities are necessary nor sufficient to produce the change needed to address the most pressing environmental issues of our time, we argue that we need people across professions, cultures, and other identity categories to increase their commitment to addressing environmental problems; in particular, those who have science skills in all types of science are needed in this fight (Shaman et al., 2013). Science and the environment have also been shown to complement each other in the classroom; for example, the inclusion of environmental/nature topics in science lessons improve emotional connections to and interest in science (Blatt, 2013; Tugurian & Carrier, 2017).

While a full accounting of both EID and SCID is beyond the scope of this paper, in the following sections we highlight some of the major trends in each area of theory and research, so that we can then consider potential intersections between the two.

Science Identity

While SCID's theoretical underpinnings largely reflect that of the wider identity literature, SCID scholars have proposed that SCID is comprised of competence, performance, and recognition by self and others (Carlone, 2022). *Recognition* refers to being seen by oneself and others as a scientist (e.g., Carlone & Johnson, 2007; Vincent-Ruz & Schunn, 2018). How those are developed and interact is viewed differently by researchers in social psychology and those who use socio-cultural learning theories. Social psychologists Simpson and Bouhafa (2020) describe five different ways that SCID studies conceptualized identity:

(a) as individual attributes,

(b) as narratives or stories,

(c) as relationships with science practices/disciplines or a sense of belonging,

(d) as a way of acting, and

(e) as afforded or constrained by local practices.

In socio-cultural theories, identity develops through interaction between micro-, meso-, and macro-educational contexts (Carlone, 2022). Micro-contexts are the social settings with which we interact each day - family, school, clubs and macro-contexts are societal structures such such as social norms and culture. Meso-contexts are where the two interact (Tudge & Rosa, 2019). As Barton (2022) describes, "Who one is and wishes to become is always in development, always shaped through social interaction with and against powered relationalities, always political, and always on the move" (p. 361). In this way, SCID is often viewed as a process, or as a "landscape of becoming" (Avraamidou, 2019, p. 325). As such, SCID has been used with groups across the lifespan and

education - students (e.g., Barton et al., 2013), college students (e.g., Hazari et al., 2013), teachers (e.g., Avraamidou, 2019; Moore, 2016), and scientists (Carlone & Johnson, 2007). There are different ways researchers can observe identity as well– what Carlone (2012) describes as snapshots and patterns over time. Snapshots look at moments in time, often using a questionnaire. This affords comparing different groups and evaluating the effectiveness of intervention and programs. Looking at patterns over time can illustrate the intersectional nature for identity, and requires commitments to examining structure/agency dialectics, looking at multiple grain sizes of analysis, and moving away from "artificial linearity" in understanding SCID over time (Carlone, 2012).

As scientists have historically been characterized as cisgendered, white, and male, many scholars in the field are interested in how education programs can be designed to expand science identity to be more inclusive of other intersectional identities in these areas (e.g., Avraadimou, 2020; Barton et al., 2013; Brickhouse et al., 2000). This can include innovations in content, style, format, recruiting, etc (Cohoon, 2007; Colvin, 2013; Davenport et al., 2021; Likely, 2022; Wyss et al., 2012) to increase diversity in the field. At a societal level such an increased diversity is seen as important both because of issues of social and epistemic justice addressing historical inequities in science and embracing non-Western ways of thinking) and because an increased diversity of scientists helps create a greater plurality of ideas (Hunter & Richmond, 2022; Stets et al., 2017).

Environmental Identity

Like SCID, environmental identity (EID) is not uniform in its definition throughout the literature (Simms, 2020), but EID research can be broadly divided into two groups: one which sees EID as alignment or relationship with the environment (usually nature) and the other which is more socially-oriented and sees EID as identifying with a social group who is interested in or advocating for the environment. A foundational example of the former is Clayton (2003), who describes EID as

> "one part of the ways in which people form their self-concept: a sense of connection to some part of the nonhuman natural environment, based on history, emotional attachment, and/or similarity, that affects the ways in which we perceive and act toward the world; a belief that the environment is important to us and an important part of who we are" (p. 45).

As such, it includes emotional, cognitive, and behavioral aspects of that relationship (Clayton et al., 2021). The triadic model constructed by Bruni et al. (2021) suggests that connectedness to nature, attitudes towards nature, and self-esteem together constitute EID.

Other researchers favor the socially-oriented perspective on EID. Kempton and Holland (2003) developed a stage-based model of "social environmental identities, that is, self-definitions with respect to one's reference group, the environmental movement, the government, the marketplace, and lifestyle choice" (p. 318) to explain why some people can hold environmental values yet not engage in environmental behaviors. Simms and Shanahan (2024) built upon Kempton

and Holland (2003) to examine students' EID development in a school setting and found that in addition to the components from the original work with adults, emotional responses and personal meaning were important forces in student EID development. Stapleton (2015) employs "sociocultural identity theory to explore how practice, action, and recognition can facilitate environmental identity development" (p. 94). While this perspective is prominent in theoretical descriptions of EID, environmental education research tends to favor Clayton's physical interpretation of EID (Simms, 2020).

Like SCID, EID is considered to be important to scholars largely because it connects to other desired outcomes, including improved wellbeing (Hinds & Sparks, 2009), increased pro-environmental behavior (Miao & Cagle, 2019), care for animals (Clayton et al., 2011), and commitment to protect the environment (Kals & Ittner, 2003).

There are several constructs that overlap and intersect with EID such as environmental ethics (Des Jardins, 2012), worldview (Dunlap et al., 2000) perceptions, beliefs (De Groot & Steg, 2007), connectedness to nature (Mayer & Frantz, 2004; Olivos et al., 2011; Schultz, 2002), and environmental agency (Huffling, 2015). These concepts are similar, but each uses different measures that focus on different underlying constructs (Balundė et al., 2019). Thus, for this paper, we chose to focus only on the construct of "environmental identity," because this term is generally grounded in the same broader psychological socio-cultural identity theories described earlier (i.e., Carlone & Johnson, 2007; Gee, 2000; Holland et al., 2001; Stapleton, 2015), and thus EID's relationship with other identity concepts can be more readily theorized and measured.

As described above, one can hold multiple identities simultaneously, sometimes these conflict and often they intersect - changing the experience of or manifestation of one or the other, or both. Taking these intersectional identities (not to be confused with intersectionality theory) into account is important for science education as a whole (Avraamidou, 2019) and supporting student success (e.g., Rodriguez et al., 2017). Research that addresses intersecting identities makes for rich narratives of identity development and maintenance. We offer that SCID and EID intersect as well, in multiple ways, and that understanding their intersection and interaction can benefit both science education and environmental education research as well as the development of a sustainable society.

Research Gap & Objectives

Both SCID and EID have rich literatures related to education, which is seen as a key mechanism by which to encourage the development of said identities (Blatt, 2013; Reidinger, 2015; Zaniewski & Reinhold, 2016). However, the two literatures have very little communication/overlap, even though they share important goals (Stapleton, 2015). More specifically, while they are both theorized to be important to the development of environmentally-committed scientists (Krasny & Tidball, 2009), and citizens who are prepared to "acquire the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment" (UNESCO/UNEP, 1978), very few studies collect data on both constructs. We argue this area of research needs expansion because environmental and science identities use similar

underlying constructs (identity theory) and should be better understood in tandem in order to design education interventions that can address the above societal goals. This work also answers calls in the science/STEM identity literature for more research on intersecting components of identity, as most papers in STEM work only focused on one element (Miao & Cagle, 2020; Simpson & Bouhafa, 2020).

We explore the selected papers to identify areas of potential communication between the works. However, because there are so few papers in this nexus, we also combine our limited data with research instruments from other EID and SCID literature to imagine how a shared research agenda might move forward, using constructs from both to envision a combined E/SCID metric suitable for future intersectional research. Ultimately, we hope that this work can help researchers and practitioners consider ways to encourage the development of interwoven environmental and science identities so that we, as individuals and as a society, can be better equipped to address the myriad environmental problems we now face, including but not limited to anthropogenic climate change, environmental racism/injustice, and ecological systems collapse (Nartova-Bochaver et al., 2022; Parris et al., 2014, 2021; Vesely et al., 2021; Wang et al., 2021).

MATERIALS & METHODS

In preparation for our scoping review, we conducted a multi-stage literature review. We first conducted a grounded theory recursive literature review search (Corbin & Strauss, 2014; Lo, 2016) on science identity, environmental identity, and both together, selecting approximately 40 of the most relevant articles for more detailed review. We chose these articles based on a combination of focus (we selected articles that were centrally focused on either EID or SCID, not just using it as part of a larger work) and visibility (we favored works that had at least 50 citations according to Google Scholar). We read these articles to familiarize ourselves with key ideas presented in these literatures and to identify areas of shared inquiry, in order to put the two literatures in conversation with one another over thematic topics. We took notes on the general topics and findings of each paper, and through discussion, generated a list of emergent thematic topics that would help us compare content across the different papers. These topics reflect the key concerns in the ID literature noted in the background section:

(1) the authors' definitions/theories of identity,

(2) the value of identity development for change,

(3) measurement techniques and instruments,

(4) population/diversity concerns, and

(5) role of education and mentorship in fostering change.

After we had identified key themes and became familiar with the literature, we conducted a scoping review to ensure we had found all relevant work. According to Munn et al. (2018), "scoping reviews are useful for examining emerging evidence when it is still unclear what other, more specific questions can be posed and valuably addressed by a more precise systematic review." A scoping review approach is more flexible than a systematic review in that it does not require a minimum sample size, and it allows more diverse inputs such as dissertations (Gutierrez-Bucheli et al., 2022; Lohr et al., 2021). Once we identified scoping review methods as the most appropriate choice, we followed Tricco et al.'s (2018) checklist for article structure and content.

Eligibility Criteria & Search Strategy

For our scoping search, we limited our search to the exact use of "environmental identity" AND "science identity". We used these exact phrases because we were looking for literature embedded in these specific discourses within the larger field of identity theory, as opposed to similar constructs embedded in other discourses. We also performed the same search using "STEM identity" in place of "science identity" and did not uncover any additional resources that were not already found with "science identity" and "environmental identity."

We searched for these terms in Google Scholar as well as the meta-search databases for both of our academic institutions. Our University databases did not turn up any resources that Google had not already found. Our last search was conducted on June 29th, 2022. We had access to all sources except for one, for which we contacted the author and obtained access to the work.

Our scoping search identified 47 articles. Due to the small initial sample, our search was not limited by year or by any other criteria, but all except for one (2007) of the 47 sources were from 2013-2022.

We then examined how each of the 47 sources employed both EID and SCID. If the text for either or both of the phrases was only present in the citations and not in the main text, we excluded the article from our sample. We eliminated 38 sources at this stage of the analysis, leaving 15 for additional review. From the remaining articles, nine articles measured either SCID or EID, and then included the other construct theoretically; those were also eliminated. We were then left with six sources that measured both EID and SCID empirically.

Data Items

We collected data from the six sources on their general attributes as well as our thematic categories. First, we summarized the basic details of our sample, including each study's conceptual focus, methods, population studied, data collected for EID/SCID, and results. We then collected additional information on the attributes selected during the grounded phase of our work:

(1) stated connections between EID and SCID constructs,

(2) authors' definitions/theories of identity,

(3) the value of identity development for change,

(4) diversity concerns, and

(5) role of education and mentorship in fostering change.

RESULTS & DISCUSSION

We present and discuss the results from our general and thematic comparisons, and then use this work alongside other existing EID and SCID research to envision a shared research agenda for environment & science identity (E/SCID).

Limitations

While each work included some conceptual inclusion and data collection for both SCID and EID, we noted that all studies presented weak theoretical connections between EID and SCID. None of them devoted more than a few sentences to the topic, and very little if any analysis was focused on the intersection of the two concepts. Identity results were also often presented as part of a larger statistical model, so its effects could not be fully separated from other variables. However, despite these limitations, we share data about these works so that they can inform future data collection efforts at the intersection of EID and SCID.

Description of Sources

Out of the six sources that met our criteria for inclusion, four of them are academic dissertations (**Table 1**). We searched for articles resulting from these dissertations, but we could not locate any other published results. We found that comparing dissertations was difficult, as they were variable lengths and formats, and extensive results were difficult to summarize. Dissertation format also makes mixed-methods more feasible, which also increased complexity of the work.

The lack of published journal articles inclusive of both EID and SCID could in part reflect the bias in academic publishing in favor of the "least publishable unit" (Broad, 1981).

Table 1. Overview of sources selected for scoping review

Citation	Study focus	Methods	Population	Data on environmental identity	Data on science identity	Results
Wallace (2018)	One control group, two groups completing citizen science project: one group using mobile tech & one using paper	Group-specific pre-post survey	137 9th grade students in three groups	Six items from Clayton's environmental identity scale, measured as part of an environmental stewardship component	Citizen science identity, mobile learning & conservation & environmentally-minded STEM interest survey: 10 item open-ended questionnaire about STEM interest & identity	Students in both intervention groups increased interest in STEM, perceptions of CEmSTEM, stewardship (measured with Clayton) & citizen science identity when compared to control group. Paper-only group also had a significant increase in environmental stewardship.
Silovsky et al. (2019)	Eco-clubs in rural settings in three states	Snapshot surveys & focus groups	252 rural youth for survey, 35 students in three focus groups	Survey: Nine novel items on EID & focus group questions on being an environmentalist, nature person, careers about nature	Adapted citizen science identity, mobile learning & conservation & environmentally-minded STEM interest survey (from Wallace, 2018); focus group questions on being a science person, pursuing science careers	EID, STEM interest, environmental science capital, & political identity help rural youth increase their environmental science capital in order to "bridge gap" & overcome barriers to pro-environmental behavior. There is tension between participants' environmental identity & other self-described identities.
Aloisio et al. (2018)	Case study of near-peer, relational mentoring program in place-based urban ecology	Pre-post surveys	139 pre-college students participating in three cohorts	Within constructs focused on perception of science & science identity, three questions flagged as items relating to environmental identity	Two validated scales, perception of science and research (eight items) & science identity (nine items)	Mentoring program strengthened science identity & intent to pursue ecology-related majors of underrepresented racial minorities in STEM careers.
Walsh and Cordero (2019)	Green Ninja Film Academy	Pre-post surveys, film & science portfolios, observations, interviews	539 middle school students, plus teachers	Identity & agency assessment (IAA) included science, environment, & climate change items; semi-structured interviews	IAA included science, environment, & climate change items; semi-structured interviews	-Average science content/practices, filmmaking and science competence, & environmental identity increased. Storytelling is key for identity development. -EID was likely to go up if it started low & go down if it started high. Perhaps low SCID/EID students were more engaged by alternative pathway program, whereas high EID/SCID students did not feel it was "science-y" enough.

Table 1 (Continued). Overview of sources selected for scoping review

Citation	Study focus	Methods	Population	Data on environmental identity	Data on science identity	Results
James (2020)	Citizen science projects, participation vs. non-participation	Two groups (participant & non-participant), surveys and practitioner interviews	964 participants in nine Australian citizen science projects, 1,446 non-participant control, eight practitioners	Nature relatedness short form scale, attitudes of environmental concern (Schultz, 2001–egoistic, altruistic, & biospheric orientations) for a motivation scale	12 item interest in science (adult version) scale	-Identifies emergent identities in citizen science related to Environmental Stewards, Science Enthusiasts and Newcomers, which should be engaged differently -Citizen Science constrained by large number of people who are just not interested
Jones (2020)	Retrospective exposure to sustainability values for women in STEM	Surveys & interviews	51 female STEM professionals	Extended inclusion of nature in self (EINS) scale (Schultz, 2001)	Inclusion of community in self (ICS) scale for STEM community; semi-structured interview questions about science career	-EINS, but not ICS, correlated with belief hat STEM should include sustainability. White participants had significantly higher EINS than African Americans. -All participants believed there was a correlation between nature & STEM, & nearly time spent in nature can help dispel misconceptions about STEM fields, possibly increasing science identity & science efficacy.

In other words, it is possible that beyond these dissertations, there are other projects that have included both SCID and EID in their variables, but their published outputs separated the results out to maximize publication count. We also found that all six of the sources were published between 2018 and 2020, suggesting that

(a) this is a relatively new field of inquiry and

(b) these dissertations may still have publications forthcoming.

Study Focus

In all six works, the authors examine the effect of an educational intervention or experience, and they are either interested in how EID/SCID shift as a result of the intervention (ID as dependent variable), or how EID/SCID scores influence other outcomes (ID as independent variable). The interventions in these six cases included citizen science projects (James, 2020; Wallace, 2018), an environmental film academy (Walsh & Cordero, 2019), student eco-clubs (Silovsky et al., 2019), a place-based urban ecology mentoring program (Aloisio et al., 2018), and sustainability values exposure for participants in a women in STEM leadership program (Jones, 2020).

In previous work, education programs including elements of citizen science, mentor programs, and artistic endeavor all have been shown elsewhere to be effective at increasing engagement and diversity in the field (Carlone et al., 2015; Matuk et al., 2021; Olson & Jackson, 2009). This trend also reflects a general call in STEM education for innovative programming to increase diversity in the field (Barton et al., 2013; Tsui, 2007), which is a promising first step for work in

this shared space. However, interestingly, while SCID tends to be more of a rigid, career/education focused concept and EID encompasses more types of constructs, both groups struggle with diversity and representation, being seen as historically white spaces. Thus, more effort is needed to diversify both the people who participate AND the socially constructed image of a person who does this work. These activities can happen simultaneously, and researchers should give voice to both of these in their work in this field.

Population Studied

Four of the six studies focus on young people (middle schoolers, high schoolers, or university students) and two on adults. This distribution could reflect the general developmental view in identity work that dictates that identity is formed when young, and becomes more stable over time (Crocetti, 2017; Grotevant, 1987; Marcia, 1980), and that educational interventions are more likely to be effective when administered in key developmental stages (Luyckx et al., 2011). However, because our sample size is so small, and our sample displayed no real convergence on specific age group, we argue that more work is needed on all stages of shared EID/SCID development.

Methods & Findings

Five of the six studies employed mixed methods. Two of the mixed-methods studies explored the general experiences of groups of interest (Jones, 2020; Silovsky et al., 2019), two of the studies employed a pre-post model surrounding an educational intervention (Aloisio et al., 2018; Walsh & Cordero, 2019), and one compared two groups of individuals, participating and nonparticipating in citizen science (James,

2020). The last study was a quantitative study with a quasi-experimental design that explored the effect of an educational program (Wallace, 2018). All mixed methods studies used a combination of surveys and either interviews, focus groups, or semi-structured interviews. However, while qualitative work was included, data on identity was more commonly found in the quantitative arm of the study (**Table 1**).

Generally speaking, all studies found some significance related to EID and/or SCID. When the goal was to increase SCID and/or EID scores in response to the intervention (citizen science or film-making program), this was achieved (Wallace, 2018; Walsh & Cordero, 2019). In the studies in which identity measurements were independent variables, existing strong identification tendencies helped them achieve their goals to participate in pro-environmental behavior (Silovsky et al., 2019) or to pursue of ecology-related degrees (Aloisio et al., 2018). James (2020) did not measure the impact of a specific intervention, but instead developed a typology in which identity-related interests could be better targeted to improve participation in citizen science projects. Finally, Jones (2020) found that retrospectively, her interviewees believed time in nature and exposure to sustainability principles (the theoretical interventions) can help individuals develop science identity. These results suggest that a future shared E/SCID agenda might be a fruitful space in which to achieve educational goals.

EID/SCID Conceptual Overlap

All six studies evoke a common narrative in which the authors argue that we need to develop both science and environmental identities in participants in order to solve environmental crises. However, the exact way in which this relationship was framed differed across projects (**Table 2**).

For James (2020) and Wallace (2018), citizen science is the crucial mechanism needed to solve environmental problems, and science and environmental identities are both embedded within a citizen science identity. For Silovsky et al. (2019), the desired outcome is an increase in pro-environmental behavior, and both SCID and EID are presented as antecedents to behavior change. For Aloisio et al. (2018), the goal is to increase both the amount and diversity of environmental science professionals, and an environmental version of science identity is the one that has the most potential for diversity and inclusion. Similarly, Jones (2020) sees both science and environmental identity as necessary for women's persistence in STEM fields. And finally, for Walsh and Cordero (2019), both SCID and EID are needed for the development of individuals who can address the climate crisis. As Wallace states, there is a gap in the literature for "developing conservation and environmentally-minded STEM (CEmsSTEM) interest and perceptions" (2018, p. 13).

Definitions of Identity

Despite the long format of a dissertation and the centrality of identity to these works, only three of the six sources provided an explicit definition of identity. These sources devoted variable amounts of space to the definition–as short as a single sentence (Wallace, 2018) to a longer paragraph (Walsh & Cordero, 2019), to an entire section (James, 2020). All three invoked social identity theory, and two went into

more nuance related to developmental and cultural theory (**Table 2**).

This suggests that the theoretical grounding of identity was rarely considered, and instead the construct was equated with an instrument often built with borrowed items. Without a robust conception of EID and SCID, there is no way to know the construct validity of the instruments used (with the exception of the authors that used previously validated measures such as Clayton, 2003). It also makes it difficult to deeply compare across studies, because the definition becomes "squishy".

This lack of focus on identity theory is problematic because without a clear concept of the theoretical underpinnings of the construct at hand, the case for the theory of change/mechanisms of change is harder to justify. However, one interesting finding was that the authors in our sample favored social identity theory, which addresses some criticism in the EID literature that researchers have not included social aspects of identity more meaningfully in measurement and definitions (Stapleton, 2015). Authors who described identity seemed to be aware of this critique and have envisioned environmental identity as a social phenomenon, not just one related to the environment directly.

Value of Identity Development for Change

Across all six sources, the authors identified and combined the key justifications for identity work embedded in existing SCID and EID literature. Namely, in SCID literature, the ultimate goal is often to get students to enter and/or remain in the sciences/STEM fields (Chen & Wei, 2020), and in EID literature, the goal is to cultivate EID for the purposes of cultivating pro-environmental behavior and support for environmental policy (Blatt, 2013; Clayton, 2003; Schmitt et al., 2019).

In this shared space, these two narratives combine to conclude that in order to address environmental crises, passionate and talented scientists are needed, so we must cultivate both an interest in understanding environmental science AND solving the environmental problems. The conclusion largely reflects the previously-discussed literature about the value of identity and the importance of considering intersecting identities in identity research (e.g., Avraamidou, 2019).

Diversity Concerns

Diversity concerns have grown consistently over time both within both the environmental movement and the STEM community, and our sample reflects these trends. All of these authors express concern about lack of diversity in environmental groups and/or science careers, and five of the six studies has an explicit goal of increasing diversity in their areas of focus, whether it be racial (Aloisio et al., 2018; Jones, 2020; Wallace, 2018; Walsh & Cordero, 2019) socio-economic (Silovsky et al., 2019), or gender (Jones, 2020; Walsh & Cordero, 2019). Yet only two studies (Aloisio et al., 2018; Jones, 2020) provided demographics for study participants. Two studies used surveys of students in schools, and so provided the demographics of the school (Walsh & Cordero, 2019) or the geographic region (Silovsky et al., 2019).

Table 2. Emergent theme data from scoping review

Citation	EID/SCID construct connections	Identity theory	Value of identity	Diversity focus	Role of education
Wallace (2018)	Citizen science key mechanism to unite EID & SCID, & citizen science Identity includes both. Citizen science is ultimately social, which can have identity development implications.	Social identity theory (Ashforth & Mael, 1989)	Citizen science identities lead to STEM careers, increased environment stewardship, knowledge of climate change.	STEM diversity needed, Black & Hispanic populations increased STEM interest after participating in project.	Education develops environment stewardship, citizen science in education can develop STEM professionals.
Silovsky et al. (2019)	Comprehensive theory of change that includes environmental identity & "STEM interest" but not science identity explicitly, although they did collect SCID data.	None provided	Identity formation is critical to develop interest in pro-environmental behavior & STEM careers.	Focused on rural youth, who are underrepresented in science.	Education increases all of the variables in their comprehensive theory of change.
Aloisio et al. (2018)	Both EID & SCID are important for increasing participation in/diversity in the ecological sciences, which are best positioned to help with ecological crisis; both were targeted by their ecology peer-mentoring program.	None provided	Identity influences career/school choices, & we need students to choose ecological science careers.	Lack of diversity in ecological fields is central to their motivation for paper/program.	Education system is the context for their mentoring program, which has the power to broaden participation in ecology.
Walsh and Cordero (2019)	In order for students to see themselves as capable of addressing climate crisis, they need to see themselves both as environmentalists who care about these issues, & as scientists who are capable of developing solutions.	Social identity theory (Kempton & Holland, 2003), cultural values/ practices (Nasir, 2002), multifaceted and contextual (Wenger, 1998)	Identity is a critical key to producing climate solutions, & easier to disentangle than interest, attitudes, behavior.	Marginalized groups need a bigger voice in climate adaptations, & white males are overrepresented.	Need learning environments that engage students to support science learning, identity development, expertise in content and practice.
James (2020)	Both EID & SCID are critical elements of citizen science identity. They identified two projects–ClimateWatch & WaterWatch–in which both EID & SCID are activated.	Psychosocial (Côté & Levine, 2002; Erikson, 1974), developmental (Burke & Stets 2009; Simon, 2004), social & contextual (Schwartz et al., 2011)	Identity drives decisions to participate in citizen science, data from which helps us address global environmental challenges.	No mention of racial/cultural factors or potential roles of them in participation, but she suggests future research should include cultural identity.	Informal education programs in citizen science can nurture different identities in science, environmental stewardship, & others.
Jones (2020)	Positions SCID & EID as potential predictors of persistence and/or belonging for women in STEM.	None provided	Identity development fosters persistence in STEM, commitment to sustainability.	Focuses on understanding double bind of women in STEM who are also of color to address issue.	Need education that includes the value of STEM for peoples' lives in order to diversify STEM. Introduces curricular model to overcome barriers for underrepresented groups.

This lack of clarity about study participants limits the potential for understanding the intersectional nature of science and environmental identity at the individual level–not only how the two interact, but also how they are influenced by individuals' other identities, such as race, ethnicity, gender, sexual orientation, and (dis)ability. What most papers in the scoping review miss is that intersectionality is potentially tremendously impactful for developing the environmentally oriented scientists and citizens of future generations - how EID and SCID influence each other and together guide behavior, which is a rich area of future study. Attention to the diversity of study participants will greatly increase the impact and generalizability of this work.

Role of Education

All of the studies in our sample consider educational experiences to be a critical part of identity development, both EID and SCID. The merging of key elements of identity development and educational experiences represents the biggest contribution of these works thus far. In particular, the importance of outdoors, hands-on experiences (in particular through citizen science), diverse program cohorts, mentor relationships, and new types of education in science (e.g., filmmaking in Walsh and Cordero, 2019), represent potentially fruitful avenues for developing E/SCID in diverse populations.

One potential tension between EID and SCID comes back to the tensions between schooling and environmental

Table 3. EID & SCID themes that emerged from analysis of instruments used in focal studies

Theme	Sample items
Environmental identity themes	
I am part of nature.	● I am part of nature (Aloisio et al., 2018).
	● *Inclusion of nature in self* scale (Jones, 2020)
	● *Connectedness to nature* scale (Silovsky et al., 2019)
I want to take care of environment.	● I want to take care of the environment (Aloisio et al., 2018).
I am aware of environmental issues.	● I am very aware of environmental issues (James, 2020).
	● I like learning about how people impact the environment (Walsh & Cordero, 2019).
Connection with more-than-human	● I think a lot about the well-being of animals (James, 2020).
	● I see myself as … someone who has a special connection with animals (Silovsky et al., 2019).
Individual/personal responsibility	● Behaving responsibly toward the Earth–living a sustainable lifestyle–is part of my moral code (Wallace, 2018).
	● It is my responsibility to take care of the environment (Walsh & Cordero, 2019).
Environmentalist	● I see myself as an environmentalist (Silovsky et al., 2019).
	● I have a lot in common with environmentalists as a group (Walsh & Cordero, 2019).
Science identity themes	
Future/career in science	● I would like to work in a science laboratory (Wallace, 2018).
	● I am interested in having a career in science (Walsh & Cordera, 2019).
Learning about science	● I enjoy learning about new scientific discoveries or inventions (James, 2020).
	● I enjoy learning about science (Wallace, 2018).
Intersection of EID & SCID	
	● There is a link between STEM and (environment/nature/sustainability) (Jones, 2020).
	● One of the most important uses of STEM is to improve/solve issues like climate change (Silovsky et al., 2019; Wallace, 2018).
	● STEM careers are interesting because they have the potential to positively impact the environmental problems in our world (Silovsky et al., 2019; Wallace, 2018).

education as a whole (Stevenson, 2007)–schooling is often hegemonic and environmental education (one of whose often–unspoken goals may be nurturing an environmental identity) often seeks to encourage dispositions and behavior that are anti-hegemonic in a capitalist society (González-Gaudiano, 2007; Stevenson, 2007). This is especially true for identities which align with social mobility goals of education. However, the two could both support democratic equality as an education priority, and we argue that the junction of the two is necessary for preparing all learners to effectively participate in a functional democracy.

Synthesis of Measurement Themes

Though EID and SCID were both represented in the studies analyzed here, they were represented very differently, as evidenced in the items used in instruments from the studies (**Table 3**). EID items were varied, including items which describe personal identities, such as "I am part of nature", "I want to take care of the environment", "individual/personal responsibility", and "connection with the more than human". Some of the instruments also included items that address a social identity ("I see myself as an environmentalist") (Silovsky et al., 2019) and "I have a lot in common with environmentalists as a group" (Walsh & Cordero, 2019). Themes from the SCID items were very STEM pipeline oriented, focusing on liking science as a topic and STEM as a future career.

These trends within our small sample reflect the greater trends present in the larger literature in these two areas, which is problematic for two reasons. First, SCID theory would benefit from adopting a more multifaceted perspective similar to EID; moving beyond career choices to focus on one's personal identities would help catch more elements of SCID. Second, the SCID focus on career alignment neglects social

identity, or the identification with a group, in this case scientists. This is key to developing the self-perception of oneself as a person who does or uses science to better the environment, which is a necessary goal in a time of increasing environmental crisis and ecosystem destabilization (Colvin, 2013). Yet only two studies within our review (Silovsky et al., 2019; Wallace, 2018) really examined the intersection of EID and SCID that would lead to that goal. Jones (2020) addressed STEM and the environment in her study of women in STEM, but these items tended towards beliefs and away from identity. Future work should investigate that intersection alongside studying the co-development of EID and SCID. Further, we argue that a greater understanding of social identity in both SCID and EID is important because a social identity may lead to larger social actions on environmental issues that would be more powerful than individual identity alone. Finally, we note the potential problems with using the word "environmentalist" when collecting data on environmental identity, as this is a particularly loaded term that could perhaps muddle the relationship between underlying EID constructs and participant responses (Shellenberger & Nordhaus, 2009).

Future Directions

Shared EID/SCID agenda

Given the clear need for a diverse community of scientists in all fields and citizens who are committed to tackling environmental problems (Hecht & Nelson, 2021), and the importance of identity formation to the commitment to both scientific inquiry and environmental behavior (Prevot et al., 2018), more empirical work is needed at the intersection of EID and SCID. The agendas within both areas have clear practical and theoretical overlap (Mileham, 2015), but this overlap needs to be clarified and the focus of further empirical development. And most importantly, scholars need to clarify

Table 4. Facets of SCID (Carlone & Johnson, 2007, p. 1191) & counterparts in EID

Facets	SCID	EID
Recognition	Seeing oneself & being seen by others as a "science" person	Seeing oneself & being seen by others as an environmentalist or someone who cares for environment
Competence	Knowledge/understanding of science content	Knowledge of environment & community resources; orientations like connection to natural world & attitudes towards nature
Performance	Social performance of relevant science practices such as ways of talking & using tools	Engagement in pro-environmental behavior & decision-making

Note. All facets occur inter-sectionally with gender, ethnic, & racial identities

Table 5. Suggested items for an E/SCID instrument, & which facet of EID/SID they address

Item	Source	Facet
Integration of nature in self (graphic)	Schultz (2002)	Part of nature[1]
I see myself as someone who cares for environment in one or more ways.	Hunter and Jordan (2019)	Care for environment
I feel that I have a lot in common with wild animals.	Clayton et al. (2021)	Connection with more-than-human
Inclusion of community in self-scale, adapted for environmental community.	Aron et al. (1992, adapted)	Inclusion in environmental community– social ID[2]
I believe that I am responsible for taking care of environment.	Hunter and Jordan (2019)	Personal responsibility to environment
I often think about one or more environmental issues.	Hunter and Jordan (2019)	Awareness of environmental issues
Venn diagram (adapted from Aron et al., 1992; Schultz et al., 2001)	New	Perceived overlap of nature & science concepts[3]
I think science is important in understanding environmental problems.	New	SID & EID intersection
I can use science to make decisions on problems in my society.	New	SID & EID intersection
I am only interested in a STEM career if I can help the environment.	Silovsky et al. (2019) & Wallace (2018)	SID & EID intersection
Science & environment are both important to me.	New	SID & EID intersection
I would like to become a scientist.	Wallace (2018)	Science career
Inclusion of community in self-scale.	Aron et al. (1992) as adapted in Jones (2020)	Social ID as scientist[4]
I enjoy learning about science.	Wallace (2018)	Enjoyment

Note. [1,2,3,4] Graphical items consisting of circles in progressive states of overlapping from distant to completely overlap

how they define identity, as not all work in this field is clear on this question. Now that we have summarized some key insights from our limited intersectional sample, we will use constructs from these works as well as foundational literature in both EID and SCID to propose a potential way forward with intersectional research on EID and SCID.

Proposed E/SCID instrument

Looking at EID and SCID through a sociocultural perspective, one that recognizes that identity develops in the interaction of micro-, meso, and macrosystems and is intersectional, we begin to see alignment between the two constructs. Using the three components of identity used by Carlone and Johnson (2007), we describe how those components look in **Table 4**.

We present a proposed instrument (**Table 5**) that addresses each of the emergent themes identified from this review. It has not been validated empirically but can serve as a starting point for those researchers that wish to study the development of EID, SID, and their intersection (E/SCID). We do not intend for it to be prescriptive for program development, rather as a synthesis of the scholarship that exists and potential paths forward, and it would be adapted to the appropriate context. For example, the instrument could be used as a pre-post measure in a summer program for teens that focuses on both science research skills and practices, in an environmental context such as a field station. This could yield insight into the effectiveness of the program in preparing young adults that see themselves as aligned with the environment, science, or

both and if that supports their action in addressing environmental problems through scientific and social avenues. As another example, the instrument could be used with practicing environmental professionals, say in an advocacy organization or lab, to develop an explanation of how these professionals identify with the environment, science, and their junction, and how this affects their work, which could help educators to understand the path towards that goal. Because so little work exists at this intersection, researchers and practitioners could consider the ways that EID and SCID intersect, but they could also envision a new, combined identity in environmental science (ESCID). At this point, we do not have enough data on this relationship to determine the best path forward. These questions could be presented in any combination, in both quantitative and qualitative data collection efforts, and could be used with diverse age cohorts in diverse settings. We recommend that it be supplemented by qualitative research that both seeks to understand the construct and helps build theory that assists in understanding their intersection.

Methods moving forward

Mixed methods were popular in our sample, which is again promising for the field. However, we found that the qualitative work exploring identity was somewhat underdeveloped. Some of the most powerful identity theory-building work has been qualitative (Brekhus, 2008; Hart & Hart, 2014), and so we argue that this area of inquiry needs some serious qualitative work to uncover more theoretical themes, which can then be tested for prevalence at a wider scale. This work could help modify and

validate our proposed E/SCID instrument, as more information is needed about how participants characterize the relationship between their own environmental and science identities, especially in the context of environmental science education programs.

Limitations

The small sample size we uncovered was the most obvious limitation to our work, but there are several others worth mentioning. First, we acknowledge that while we were able to justify our choice of eliminating related constructs, doing so might have caused us to miss potentially valuable work in this relatively new field. Second, four of the six papers we reviewed were doctoral dissertations. Dissertations are written under substantively different constraints than journal articles, which makes them difficult to compare directly to other forms of work. Lastly, the research reviewed here was all conducted in Western countries, with little cultural or social diversity, and so represent a limited view of identity as a whole.

CONCLUSIONS

Our scoping review has found that while there are solid theoretical calls for more work at the intersection of EID and SCID, there is scant empirical data exploring this intersection. Our review takes stock of the limited existing literature, exploring common themes in diversity, educational programming, methods, and identity theory. We use this analysis to produce an instrument that could simultaneously explore environmental and science identity (E/SCID). Next steps include validating these instruments with survey and interview data to better understand how EID and SCID develop within individuals and communities to inspire a diverse group of environmentally-minded scientists to address the most pressing environmental issues of our time.

REFERENCES

Aloisio, J. M., Johnson, B., Lewis, J. D., Clark, J. A., Munshi-South, J., Roberts, S.-J., Wasserman, D., Heimlich, J., & Tingley, K. (2018). Pre-college urban ecology research mentoring: Promoting broader participation in the field of ecology for an urban future. *Journal of Urban Ecology, 4*(1). https://doi.org/10.1093/jue/juy023

Altugan, A. S. (2015). The relationship between cultural identity and learning. *Procedia-Social and Behavioral Sciences, 186*, 1159-1162. https://doi.org/10.1016/j.sbspro.2015.04.161

Amiot, C. E., De la Sablonniere, R., Terry, D. J., & Smith, J. R. (2007). Integration of social identities in the self: Toward a cognitive-developmental model. *Personality and Social Psychology Review, 11*(4), 364-388. https://doi.org/10.1177/1088868307304091

Aron, A., Aron, E. N., & Smollan, D. (1992). Inclusion of other in the self-scale and the structure of interpersonal closeness. *Journal of Personality and Social Psychology, 63(*4), 596-612. https://doi.org/10.1037/0022-3514.63.4.596

Ashforth, B. E., & Mael, F. (1989). Social identity theory and the organization. *Academy of Management Review, 14*(1), 20-39. https://doi.org/10.2307/258189

Avraamidou, L. (2020). Science identity as a landscape of becoming: Rethinking recognition and emotions through an intersectionality lens. *Cultural Studies of Science Education, 15*(2), 323-345. https://doi.org/10.1007/s11422-019-09954-7

Balundė, A., Jovarauskaitė, L., & Poškus, M. S. (2019). Exploring the relationship between connectedness with nature, environmental identity, and environmental self-identity: A systematic review and meta-analysis. *Sage Open, 9*(2). https://doi.org/10.1177/2158244019841925

Barton, A., & Tan, E. (2022). Infrastructuring for justice: Reframing scale through a rightful presence framework. In *Proceedings of the 16th International Conference of the Learning Sciences* (pp. 353-360). International Society of the Learning Sciences.

Barton, A., Kang, H., Tan, E., O'Neill, T. B., Bautista-Guerra, J., & Brecklin, C. (2013). Crafting a future in science: Tracing middle school girls' identity work over time and space. *American Educational Research Journal, 50*(1), 37-75. https://doi.org/10.3102/0002831212458142

Battey, D., & Leyva, L. A. (2016). A framework for understanding whiteness in mathematics education. *Journal of Urban Mathematics Education, 9*(2). https://doi.org/10.21423/jume-v9i2a294

Berry III, R. Q., Thunder, K., & McClain, O. L. (2011). Counter narratives: Examining the mathematics and racial identities of Black boys who are successful with school mathematics. *Journal of African American Males in Education, 2*(1), 10-23.

Blatt, E. N. (2013). Exploring environmental identity and behavioral change in an environmental science course. *Cultural Studies of Science Education, 8*(2), 467-488. https://doi.org/10.1007/s11422-012-9459-2

Blustein, D. L., Devenis, L. E., & Kidney, B. A. (1989). Relationship between the identity formation process and career development. *Journal of Counseling Psychology, 36*(2), Article 196. https://doi.org/10.1037/0022-0167.36.2.196

Brekhus, W. H. (2008). Trends in the qualitative study of social identities. *Sociology Compass, 2*(3), 1059-1078. https://doi.org/10.1111/j.1751-9020.2008.00107.x

Brickhouse, N. W., Lowery, P., & Schultz, K. (2000). What kind of a girl does science? The construction of school science identities. *Journal of Research in Science Teaching, 37*(5), 441-458. https://doi.org/10.1002/(SICI)1098-2736(200005)37:5<441::AID-TEA4>3.0.CO;2-3

Broad, W. J. (1981). The publishing game: Getting more for less: Meet the least publishable unit, one way of squeezing more papers out of a research project. *Science, 211*(4487), 1137-1139. https://doi.org/10.1126/science.7008199

Bruni, C. M., Schultz, P. W., & Woodcock, A. (2021). The balanced structure of environmental identity. *Sustainability, 13*(15), Article 8168. https://doi.org/10.3390/su13158168

Burke, P. J., & Stryker, S. (2016). Identity theory: Progress in relating the two strands. In J. E. Stets, & R. T. Serpe (Eds.), *New directions in identity theory and research* (pp. 657-682). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780190457532.003.0023

Burke, P., & Stets, J. (2009). The roots of identity theory. In P. J. Burke, & J. E. Stets (Eds.), *Identity theory*. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195388275.003.0012

Capobianco, B. M. (2006). Undergraduate women engineering their professional identities. *Journal of Women and minorities in Science and Engineering, 12*(2-3). https://doi.org/10.1615/JWomenMinorScienEng.v12.i2-3.10

Carlone, H. B. (2012). Methodological considerations for studying identities in school science: An anthropological approach. In M. Varelas (Ed.), *Identity construction and science education research* (pp. 7-25). Brill. https://doi.org/10.1007/978-94-6209-043-9_2

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching, 44*(8), 1187-1218. https://doi.org/10.1002/tea.20237

Carlone, H. B., Huffling, L. D., Tomasek, T., Hegedus, T. A., Matthews, C. E., Allen, M. H., & Ash, M. C. (2015). 'Unthinkable' selves: Identity boundary work in a summer field ecology enrichment program for diverse youth. *International Journal of Science Education, 37*(10), 1524-1546. https://doi.org/10.1080/09500693.2015.1033776

Carrier, S. J., Tugurian, L. P., & Thomson, M. M. (2013). Elementary science indoors and out: Teachers, time, and testing. *Research in Science Education, 43*(5), 2059-2083. https://doi.org/10.1007/s11165-012-9347-5

Chen, S., & Wei, B. (2020). Development and validation of an instrument to measure high school students' science identity in science learning. *Research in Science Education, 55*, 111-126. https://doi.org/10.1007/s11165-020-09932-y

Clayton, S. (2003). Environmental identity: A conceptual and an operational definition. In S. Clayton, & S. Opotow (Eds.), *Identity and the natural environment: The psychological significance of nature* (pp. 45-65). MIT Press. https://doi.org/10.7551/mitpress/3644.003.0005

Clayton, S., Czellar, S., Nartova-Bochaver, S., Skibins, J. C., Salazar, G., Tseng, Y. C., Irkhin, B., & Monge-Rodriguez, F. S. (2021). Cross-cultural validation of a revised environmental identity scale. *Sustainability, 13*(4), Article 2387. https://doi.org/10.3390/su13042387

Clayton, S., Fraser, J., & Burgess, C. (2011). The role of zoos in fostering environmental identity. *Ecopsychology, 3*(2), 87-96. https://doi.org/10.1089/eco.2010.0079

Cobern, W. W., Gibson, A. T., & Underwood, S. A. (1999). Conceptualizations of nature: An interpretive study of 16 ninth graders' everyday thinking. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching, 36*(5), 541-564. https://doi.org/10.1002/(SICI)1098-2736(199905)36:5<541::AID-TEA3>3.0.CO;2-1

Cohoon, J. P. (2007). An introductory course format for promoting diversity and retention. In *Proceedings of the 38th SIGCSE Technical Symposium on Computer Science Education* (pp. 395-399). https://doi.org/10.1145/1227310.1227450

Colvin, C. R. (2013). *Significant life experience: Exploring the lifelong influence of place-based environmental and science education on program participants* [PhD thesis, University of Colorado at Denver].

Corbin, J., & Strauss, A. (2014). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. SAGE.

Côté, J. E., & Levine, C. G. (2014). *Identity, formation, agency, and culture: A social psychological synthesis*. Psychology Press. https://doi.org/10.4324/9781410612199

Crocetti, E. (2017). Identity formation in adolescence: The dynamic of forming and consolidating identity commitments. *Child Development Perspectives, 11*(2), 145-150. https://doi.org/10.1111/cdep.12226

Davenport, C., Dele-Ajayi, O., Emembolu, I., Morton, R., Padwick, A., Portas, A., Sanderson, J., Shimwell, J., Stonehouse, J., Strachan, R., Wake, L., Wells, G., & Woodward, J. (2021). A theory of change for improving children's perceptions, aspirations and uptake of STEM careers. *Research in Science Education, 51*(4), 997-1011. https://doi.org/10.1007/s11165-019-09909-6

De Groot, J. I., & Steg, L. (2007). Value orientations and environmental beliefs in five countries: Validity of an instrument to measure egoistic, altruistic and biospheric value orientations. *Journal of Cross-cultural Psychology, 38*(3), 318-332. https://doi.org/10.1177/0022022107300278

Des Jardins, J. R. (2012). *Environmental ethics*. Cengage Learning.

Dunlap, R. E., Van Liere, K. D., Mertig, A. G., & Jones, R. E. (2000). New trends in measuring environmental attitudes: Measuring endorsement of the new ecological paradigm: A revised NEP scale. *Journal of Social Issues, 56*(3), 425-442. https://doi.org/10.1111/0022-4537.00176

Erikson, E. (1974). *Dimensions of a new identity, Jefferson lecture in the humanities*. W.W. Norton & Company Inc.

Falk, J. H. (2016). *Identity and the museum visitor experience*. Routledge. https://doi.org/10.4324/9781315427058

Flum, H., & Kaplan, A. (2012). Identity formation in educational settings: A contextualized view of theory and research in practice. *Contemporary Educational Psychology, 37*(3), 240-245. https://doi.org/10.1016/j.cedpsych.2012.01.003

Funk, C. (2017). Mixed messages about public trust in science. *Issues in Science and Technology, 34*(1), 86-88.

Gee, J. P. (2000). Chapter 3: Identity as an analytic lens for research in education. *Review of Research in Education, 25*(1), 99-125. https://doi.org/10.3102/0091732X025001099

Giampapa, F. (2010). Multiliteracies, pedagogy and identities: Teacher and student voices from a Toronto elementary school. *Canadian Journal of Education/Revue canadienne de l'éducation, 33*(2), 407-431.

Grotevant, H. D. (1987). Toward a process model of identity formation. *Journal of Adolescent Research, 2*(3), 203-222. https://doi.org/10.1177/074355488723003

Gutierrez-Bucheli, L., Reid, A., & Kidman, G. (2022). Scoping reviews: Their development and application in environmental and sustainable education research. *Environmental Education Research, 28*(5), 645-673. https://doi.org/10.1080/13504622.2022.2047896

Hart, P., & Hart, C. (2014). It's not that simple anymore: Engaging the politics of culture and identity within environmental education/education for sustainable development (EE/ESD). In J. Chi-Kin Lee, & R. Efird (Eds.), *Schooling for sustainable development across the Pacific* (pp. 37-57). Springer. https://doi.org/10.1007/978-94-017-8866-3_2

Hazari, Z., Sadler, P. M., & Sonnert, G. (2013). The science identity of college students: Exploring the intersection of gender, race, and ethnicity. *Journal of College Science Teaching, 42*(5), 82-91.

Hecht, M., & Nelson, T. (2021). Youth, place, and educator practices: Designing program elements to support relational processes and naturalist identity development. *Environmental Education Research, 27*(9), 1401-1420. https://doi.org/10.1080/13504622.2021.1928608

Hinds, J., & Sparks, P. (2009). Investigating environmental identity, well-being, and meaning. *Ecopsychology, 1*(4), 181-186. https://doi.org/10.1089/eco.2009.0026

Hogg, M. A., Terry, D. J., & White, K. M. (1995). A tale of two theories: A critical comparison of identity theory with social identity theory. *Social Psychology Quarterly, 58*(4), 255-269. https://doi.org/10.2307/2787127

Holland, D., Lachicotte Jr, W., Skinner, D., & Cain, C. (2001). *Identity and agency in cultural worlds.* Harvard University Press.

Huffling, L. D. (2015). *Critical environmental agency in a field ecology program* [PhD thesis, The University of North Carolina at Greensboro].

Hunter, R. H., & Jordan, R. C. (2019). The TELA: A new tool for assessing educator environmental literacy. *Interdisciplinary Journal of Environmental and Science Education, 15*(1), e02201. https://doi.org/10.29333/ijese/6286

Hunter, R. H., & Richmond, G. (2022). Theoretical diversity and inclusivity in science and environmental education research: A way forward. *Journal of Research in Science Teaching, 59*(6), 1065-1085. https://doi.org/10.1002/tea.21752

Jacobs, A. D. (1971). Women in law school: Structural constraint and personal choice in the formation of professional identity. *Journal of Legal Education, 24*, Article 462.

James, N. L. (2020). *Identity and participation in citizen science* [Doctoral dissertation, University of South Australia].

Jones, T. E. (2020). *Sustainability and success in STEM: An ethnography of females and their experiences in the field* [Doctoral dissertation, Prescott College].

Kals, E., & Ittner, H. (2003). Children's environmental identity: Indicators and behavioral impacts. In S. Clayton, & S. Opotow (Eds.), *Identity and the natural environment: The psychological significance of nature* (pp. 135-157). MIT Press. https://doi.org/10.7551/mitpress/3644.003.0009

Kempton, W., & Holland, D. C. (2003). Identity and sustained environmental practice. In S. Clayton, & S. Opotow (Eds.), *Identity and the natural environment: The psychological significance of nature* (pp. 317). MIT Press. https://doi.org/10.7551/mitpress/3644.003.0019

Kim-Prieto, C., Copeland, H. L., Hopson, R., Simmons, T., & Leibowitz, M. J. (2013). The role of professional identity in graduate school success for under-represented minority students. *Biochemistry and Molecular Biology Education, 41*(2), 70-75. https://doi.org/10.1002/bmb.20673

Krasny, M. E., & Tidball, K. G. (2009). Applying a resilience systems framework to urban environmental education. *Environmental Education Research, 15*(4), 465-482. https://doi.org/10.1080/13504620903003290

Likely, R. (2022). Learning through the curls: How hair culture can expand science and social studies. *Black History Bulletin, 85*(2), 30-32. https://doi.org/10.1353/bhb.2022.0010

Lo, C. O. (2016). Literature integration: An illustration of theoretical sensitivity in grounded theory studies. *The Humanistic Psychologist, 44*(2), Article 177. https://doi.org/10.1037/hum0000029

Lohr, A. M., Krause, K. C., McClelland, D. J., Van Gorden, N., Gerald, L. B., Del Casino Jr, V., Wilkinson-Lee, A., & Carvajal, S. C. (2021). The impact of school gardens on youth social and emotional learning: A scoping review. *Journal of Adventure Education and Outdoor Learning, 21*(4), 371-384. https://doi.org/10.1080/14729679.2020.1838935

Luyckx, K., Schwartz, S. J., Goossens, L., Beyers, W., & Missotten, L. (2011). Processes of personal identity formation and evaluation. In S. J. Schwartz, K. Luyckx, & V. L. Vignoles (Eds.), *Handbook of identity theory and research* (pp. 77-98). Springer. https://doi.org/10.1007/978-1-4419-7988-9_4

Marcia, J. E. (1980). Identity in adolescence. *Handbook of Adolescent Psychology, 9*(11), 159-187.

Matuk, C., Hurwich, T., Spiegel, A., & Diamond, J. (2021). How do teachers use comics to promote engagement, equity, and diversity in science classrooms? *Research in Science Education, 51*, 685-732. https://doi.org/10.1007/s11165-018-9814-8

Mayer, F. S., & Frantz, C. M. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology, 24*(4), 503-515. https://doi.org/10.1016/j.jenvp.2004.10.001

McCarthey, S. J. (2001). Identity construction in elementary readers and writers. *Reading Research Quarterly, 36*(2), 122-151. https://doi.org/10.1598/RRQ.36.2.2

Mead, G. H. (1934). *Mind, self, and society*. University of Chicago Press.

Miao, R. E., & Cagle, N. L. (2020). The role of gender, race, and ethnicity in environmental identity development in undergraduate student narratives. *Environmental Education Research, 26*(2), 171-188. https://doi.org/10.1080/13504622.2020.1717449

Mileham, M. A. (2015). *Using narratives to document environmental identities and connection to nature: A case study of aquarium staff and volunteers* [Doctoral dissertation, Oregon State University].

Morton, T. A., Haslam, S. A., Postmes, T., & Ryan, M. K. (2006). We value what values us: The appeal of identity-affirming science. *Political Psychology, 27*(6), 823-838. https://doi.org/10.1111/j.1467-9221.2006.00539.x

Munn, Z., Peters, M.D.J., Stern, C. et al. (2018) Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Med Res Methodol, 18*, Article 143. https://doi.org/10.1186/s12874-018-0611-x

Nartova-Bochaver, S. K., Donat, M., Ucar, G. K., Korneev, A. A., Heidmets, M. E., Kamble, S., Khachatryan, N., Kryazh, I. V., Larionow, P., Rodrigues-Gonzalez, D., Serobyan, A., Zhou, C., & Clayton, S. (2022). The role of environmental identity and individualism/collectivism in predicting climate change denial: Evidence from nine countries. *Journal of Environmental Psychology, 84*, Article 101899. https://doi.org/10.1016/j.jenvp.2022.101899

Nasir, N. I. S. (2002). Identity, goals, and learning: Mathematics in cultural practice. *Mathematical Thinking and Learning, 4*(2-3), 213-247. https://doi.org/10.1207/S15327833MTL04023_6

Nauroth, P., Gollwitzer, M., Bender, J., & Rothmund, T. (2015). Social identity threat motivates science-discrediting online comments. *PLoS ONE, 10*(2), Article e0117476. https://doi.org/10.1371/journal.pone.0117476

Olivos, P., & Aragonés, J. I. (2011). Psychometric properties of the environmental identity scale (EID). *Psyecology, 2*(1), 65-74. https://doi.org/10.1174/217119711794394653

Olivos, P., Aragonés, J. I., & Amérigo, M. (2011). The connectedness to nature scale and its relationship with environmental beliefs and identity. *International Journal of Hispanic Psychology, 4*(1), 5-19.

Olson, D. A., & Jackson, D. (2009). Expanding leadership diversity through formal mentoring programs. *Journal of Leadership Studies, 3*(1), 47-60. https://doi.org/10.1002/jls.20095

Parris, C. L., Hegtvedt, K. A., & Johnson, C. (2021). Assessments of environmental injustice among Black Americans. *Social Currents, 8*(1), 45-63. https://doi.org/10.1177/2329496520950808

Parris, C. L., Hegtvedt, K. A., Johnson, C., & Watson, L. (2014). Justice for all? Factors affecting perceptions of environmental and ecological injustice. *Social Justice Research, 27*(1), 67-98. https://doi.org/10.1007/s11211-013-0200-4

Prévot, A. C., Clayton, S., & Mathevet, R. (2018). The relationship of childhood upbringing and university degree program to environmental identity: Experience in nature matters. *Environmental Education Research, 24*(2), 263-279. https://doi.org/10.1080/13504622.2016.1249456

Riedinger, K. (2015). Identity development of youth during participation at an informal science education camp. *International Journal of Environmental and Science Education, 10*(3), 453-475.

Rodriguez, S. L., Cunningham, K., & Jordan, A. (2017). What a scientist looks like: How community colleges can utilize and enhance science identity development as a means to improve success for women of color. *Community College Journal of Research and Practice, 41*(4-5), 232-238. https://doi.org/10.1080/10668926.2016.1251354

Rynes, S. L., Colbert, A. E., & O'Boyle, E. H. (2018). When the "best available evidence" doesn't win: How doubts about science and scientists threaten the future of evidence-based management. *Journal of Management, 44*(8), 2995-3010. https://doi.org/10.1177/0149206318796934

Schmitt, M. T., Mackay, C. M., Droogendyk, L. M., & Payne, D. (2019). What predicts environmental activism? The roles of identification with nature and politicized environmental identity. *Journal of Environmental Psychology, 61,* 20-29. https://doi.org/10.1016/j.jenvp.2018.11.003

Schultz, P. W. (2002). Inclusion with nature: The psychology of human-nature relations. P. Schmuck, & W. P. Schultz (Eds.), *Psychology of Sustainable Development* (pp. 61-78). Springer. https://doi.org/10.1007/978-1-4615-0995-0_4

Schwartz, S. J. (2001). The evolution of Eriksonian and neo-Eriksonian identity theory and research: A review and integration. *Identity: An International Journal of Theory and Research, 1*(1), 7-58. https://doi.org/10.1207/S1532706 XSCHWARTZ

Schwartz, S. J., Luyckx, K., & Vignoles, V. L. (2011). *Handbook of identity theory and research*. Springer. https://doi.org/10.1007/978-1-4419-7988-9

Schultz, P. W. (2001). The structure of environmental concern: Concern for self, other people, and the biosphere. *Journal of Environmental Psychology, 21*(4), 327-339. https://doi.org/10.1006/jevp.2001.0227

Shaman, J., Solomon, S., Colwell, R. R., & Field, C. B. (2013). Fostering advances in interdisciplinary climate science. *PNAS, 110*(supplement_1), 3653-3656. https://doi.org/10.1073/pnas.1301104110

Shellenberger, M., & Nordhaus, T. (2009). The death of environmentalism. *Geopolitics, History, and International Relations, 1*(1), 121-163.

Shinbrot, X. A., Jones, K. W., Solomon, J., & Escobedo, M. R. (2022). Examining the influence of citizen science participation on individual volunteers in the global South: A case study of hydrologic monitors in Veracruz, Mexico. *The Journal of Environmental Education, 53*(1), 6-21. https://doi.org/10.1080/00958964.2021.1984193

Silovsky, P. A., Donlan, M. L., & Flotte, E. C. (2019). *Environmental science and culture: Exploring the factors contributing to the pro-environmental behavior of rural youth* [Doctoral dissertation, University of Missouri-St Louis].

Simms, W. (2020). Bringing environmental identity research into the classroom context: Examining the theoretical foundations influencing its current use in the literature. *Studies in Science Education, 56*(1), 35-76. https://doi.org/10.1080/03057267.2020.1736379

Simms, W., & Shanahan, M. C. (2024). Qualitatively recognizing the dimensions of student environmental identity development within the classroom context. *Journal of Research in Science Teaching, 61*, 3-37. https://doi.org/10.1002/tea.21863

Simon, B. (2004). *Identity in modern society: A social psychological perspective*. Blackwell Publishing. https://doi.org/10.1002/9780470773437

Simpson, A., & Bouhafa, Y. (2020). Youths' and adults' identity in STEM: A systematic literature review. *Journal for STEM Education Research, 3*(2), 167-194. https://doi.org/10.1007/s41979-020-00034-y

Stapleton, S. R. (2015). Environmental identity development through social interactions, action, and recognition. *The Journal of Environmental Education, 46*(2), 94-113. https://doi.org/10.1080/00958964.2014.1000813

Stets, J. E., & Burke, P. J. (2000). Identity theory and social identity theory. *Social Psychology Quarterly, 63*(3), 224-237. https://doi.org/10.2307/2695870

Stets, J. E., Brenner, P. S., Burke, P. J., & Serpe, R. T. (2017). The science identity and entering a science occupation. *Social Science Research, 64*, 1-14. https://doi.org/10.1016/j.ssresearch.2016.10.016

Stevenson, A. D., Gallard Martínez, A. J., Brkich, K. L., Flores, B. B., Claeys, L., & Pitts, W. (2019). Latinas' heritage language as a source of resiliency: Impact on academic achievement in STEM fields. *Cultural Studies of Science Education, 14*, 1-13. https://doi.org/10.1007/s11422-016-9789-6

Stirling, A. (2014). Disciplinary dilemma: Working across research silos is harder than it looks. *The Guardian, 11*.

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, C., … Straus, S. E. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine, 169*(7), 467-473. https://doi.org/10.7326/M18-0850

Tsui, L. (2007). Effective strategies to increase diversity in STEM fields: A review of the research literature. *The Journal of Negro Education, 76*(4), 555-581.

Tudge, J., & Rosa, E. M. (2019). Bronfenbrenner's ecological theory. In *The encyclopedia of child and adolescent development* (pp. 1-11). Wiley. https://doi.org/10.1002/9781119171492.wecad251

Tugurian, L. P., & Carrier, S. J. (2017). Children's environmental identity and the elementary science classroom. *The Journal of Environmental Education, 48*(3), 143-153. https://doi.org/10.1080/00958964.2016.1191415

UNESCO/UNEP. (1978). The Tbilisi declaration. *Connect, UNESCO-UNEP Environmental Education Newsletter, 111*(1).

Verhoeven, M., Poorthuis, A. M., & Volman, M. (2019). The role of school in adolescents' identity development. A literature review. *Educational Psychology Review, 31*, 35-63. https://doi.org/10.1007/s10648-018-9457-3

Vesely, S., Masson, T., Chokrai, P., Becker, A. M., Fritsche, I., Klöckner, C. A., Tiberio, L., Carrus, G., & Panno, A. (2021). Climate change action as a project of identity: Eight meta-analyses. *Global Environmental Change, 70*, Article 102322. https://doi.org/10.1016/j.gloenvcha.2021.102322

Vignoles, V. L., Schwartz, S. J., & Luyckx, K. (2011). Introduction: Toward an integrative view of identity. In S. J. Schwartz, K. Luyckx, & V. L. Vignoles (Eds.), *Handbook of identity theory and research* (pp. 1-27). Springer. https://doi.org/10.1007/978-1-4419-7988-9_1

Vincent-Ruz, P., & Schunn, C. D. (2018). The nature of science identity and its role as the driver of student choices. *International Journal of STEM Education, 5*(1), 1-12. https://doi.org/10.1186/s40594-018-0140-5

Wallace, D. E. (2018). *Creating citizen science identity: Growing conservation and environmentally-minded STEM interest through mobile learning and authentic practice* [Doctoral dissertation, Lehigh University].

Walsh, E. M., & Cordero, E. (2019). Youth science expertise, environmental identity, and agency in climate action filmmaking. *Environmental Education Research, 25*(5), 656-677. https://doi.org/10.1080/13504622.2019.1569206

Wang, X., Van der Werff, E., Bouman, T., Harder, M. K., & Steg, L. (2021). I am vs. we are: How biospheric values and environmental identity of individuals and groups can influence pro-environmental behaviour. *Frontiers in Psychology, 12*, Article 618956. https://doi.org/10.33073/pjm-2021-027

Watson, G. (2005). The hidden curriculum in schools: Implications for lesbian, gay, bisexual, transgender, and queer youth. *Alternate Routes: A Journal of Critical Social Research, 21*.

Wenger, E. (1998). Communities of practice: Learning as a social system. *Systems Thinker, 9*(5), 2-3.

Wynne, B. (2016). Misunderstood misunderstanding: Social identities and public uptake of science. *Public Understanding of Science, 1*(3), 281-304. https://doi.org/10.1088/0963-6625/1/3/004

Wyss, V. L., Heulskamp, D., & Siebert, C. J. (2012). Increasing middle school student interest in STEM careers with videos of scientists. *International Journal of Environmental and Science Education, 7*(4), 501-522.

Zaniewski, A. M., and Reinholz, D. (2016) Increasing STEM success: A near-peer mentoring program in the physical sciences, *International Journal of STEM Education, 3*, 1-12. https://doi.org/10.1186/s40594-016-0043-2