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The Role of Identity in STEM Learning and Science Communication

Reflections on Interviews from the Field

Background

With the launch of the National Research Council's 2009 consensus report, *Learning Science in Informal Environments*, the concept of "identity" has become an increasingly important factor in the study of informal science, technology, engineering, and math (STEM) education and science communication. Based on a review of the literature at the time, the report proposed six "strands of science learning," one of which was that learners in informal environments "think about themselves as science learners and develop an identity as someone who knows about, uses and sometime contributes to science."

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And a growing number of designers name an enhanced science or STEM identity as an intended outcome for participants in their activities and programs.

In 2017, the Center for Advancement of Informal Science Education (CAISE) conducted a series of interviews with 13 researchers who are designing for and/or studying the impacts of informal STEM learning and science communication experiences and settings on participants' STEM identities. We asked these professionals how they conceptualized identity, if and how they measured it, and how various identities intersect to either reinforce or hinder one's identity as someone who understands, applies, and can contribute to STEM.

We learned that in the broadest sense, identity can be defined as an individually and socially constructed sense of self. In everyday language, one might define identity as the way that people answer questions such as: "Who do I think I am, or who can I be, where do I belong, and how do I think other people see me?" Identity can be both the way one sees oneself and the way one is recognized by others in a social context.

Who we interviewed

Angela Johnson
Professor of Educational Studies, St. Mary's College of Maryland

Dale McCreedy
Vice President of Audience and Community Engagement, Discovery Center at Murfree Spring

Dan Kahan
Professor of Law and Psychology, Yale University

Edna Tan
Associate Professor of Science Education. University of North Carolina, Greensboro

Erik Nisbet
Associate Professor of Communication, Ohio State University

Heidi Ballard
Founder and Faculty Director of the Center for Community and Citizen Science, University of California, Davis

Heidi Carlone
Hooks Distinguished Professor of STEM Education, University of North Carolina, Greensboro

Jacque Eccles
Distinguished Professor of Education, University of California, Irvine

Jennifer Adams
Associate Professor, University of Calgary

Kevin Binning
Associate Professor of Psychology, University of Pittsburgh

Lynn Dierking
Professor and Associate Dean for Research, Oregon State University

Shelly Valdez
President, Native Pathways

Zahra Hazari
Associate Professor of Science Education, Florida International University

Identity is studied across the social sciences, and the researchers that we interviewed think and write about it in both similar and different ways. Some social psychologists, for instance, might frame identity as an individual attribute, while learning researchers, through a sociocultural lens, describe identity as socially negotiated and constructed through relationships and interactions with others (e.g. Eccles and Binning). Several of the researchers we interviewed talked about identity "work," or how identity is negotiated through social interactions in different contexts (e.g. Tan). Across the disciplinary perspectives many of our interviewees conceptualized STEM identity as situated and context dependent.

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Some that we interviewed describe the concept of multiple identities (i.e., that individuals can have many different identities and that some are more basic or foundational to their sense of self). Related to this idea is the notion of "intersectionality"—that a person's various identities can be reinforcing or in competition with one another. For example, some researchers study how, and in what ways, various identities (e.g., gender, ethnic, or racial identity) overlap or intersect to influence an individual's STEM identity (e.g. Dierking, McCreedy and Adams). Some researchers we interviewed study identity development within the STEM disciplines e.g. a physics, biology or engineering identity (e.g. Johnson and Hazari). We also found that some evaluators and researchers working with indigenous audiences may not find it useful to conceptualize or measure identity as something separate in their holistic view of an individual developing and learning as part of a community (e.g. Valdez).

Ethnic, gender, class, cultural or political identities have been studied extensively, and some researchers and practitioners have also explored how issues of power influence identity (e.g. Carlone and Ballard).

The identities that people construct can be marginalized by dominant cultural and structural norms in STEM. Researchers who take a critical perspective by problematizing these power structures examine how traditional norms, structures, practices, and expectations in STEM can constrain identities.

Why is understanding identity important?

One reason for the increasing interest in identity is that people who develop identities related to STEM engage with these topics more often and more deeply. A science identity, for example, increases the likelihood that students will, over the long term, continue to develop science literacy or even follow an educational pathway toward a science career or profession that requires or benefits from education or training in STEM.

The way that identity shapes learning is through the evolving choices and expectations of a learner. When people engage with STEM, having a STEM identity influences their expectations of how

interesting and successful the experience will be. If they find the experience to be engaging and satisfying, the experience will then strengthen their STEM identity, leading to a positive feedback loop that can reinforce ongoing participation and learning. Conversely, when learners have less engaging or unsuccessful experiences, a negative feedback loop can result—and might erode a developing STEM identity and make it less likely a learner will choose to participate in related activities in the future.

Some researchers who study science communication are interested in how a political orientation or cultural worldview can determine the degree to which people are attentive to information, whether they trust scientific sources, and how they process scientific evidence, since all of these may depend on values that underlie a sense of identity. Being liberal or conservative, or having a hierarchical or communitarian orientation, for example, can influence how people perceive and process data, especially when it comes to so-called "controversial" issues such as global climate change (e.g. Kahan and Nisbet).

This type of research tends to focus on the design of learning and communication activities for adults aimed at influencing their civic or personal decisions and choices. In contrast, the questions that learning researchers study tend to focus on experiences and settings that contribute to STEM identities that develop in learners over time.

Can identity be measured and if so, how?

Across the interviews CAISE conducted, there were varied opinions regarding whether or not identity can actually be measured. Identity was viewed by some as a concept that is not directly observable or measurable. Some researchers noted that a variety of data collection strategies can provide some evidence of aspects of an individual's identity. Several of the interviewees also pointed out that these various data collection efforts capture only a snapshot of an individual's identity in a moment and context.

We learned that science or STEM identity can be observed or documented in a variety of ways through both quantitative and qualitative approaches, and there are existing resources that researchers, evaluators, and designers can draw upon. One approach is open-ended interviews in which researchers ask people to talk about their identities, the impact of identity on their lives, the role of their identity in their learning history, and their expectations of their goals for the future. Sometimes researchers observe people in STEM learning contexts, noting how identity is expressed, performed, and changed. When such embedded, ethnographic work occurs over time, researchers and evaluators can follow trajectories of participation and reveal the complex dynamics of how different identities intersect and influence choice, behavior, and learning.

When researchers have questions that involve larger numbers of research subjects, they often rely on self-report measures consisting of a group of individual items that ask those surveyed about how they see themselves in relationship to STEM, and how they perceive that others see them with respect to STEM. Researchers and evaluators often tailor their particular survey questions to the specifics of the audience or content being studied, as there is no standard measure of identity. This might require items (questions or statements requiring a response) that measure identity with respect to the subtopics of STEM (science, technology, engineering, and math), or disciplines within the field

of science (e.g., biology, physics, chemistry). Different items are required to measure identity when working with children, undergraduates, or adults. Validated, reliable scales (tools by which individuals are distinguished as to how they differ from one another on the variables being studied) of various lengths for STEM identity can be found in the extant literature. In addition to surveys, other techniques, such as implicit association tests can provide behavioral measures of identity. These tests measure relative reaction time to a (mostly) visual stimulus (e.g., pictures of scientists, physicians, artists, mechanics, etc., or pictures depicting activities such as working with test tubes, cars, office equipment, farm equipment, etc.). The faster the reaction to a prompt, the more likely it is that the person identifies with the image.

How is STEM identity development supported?

Designed experiences, such as educational programs, museum exhibits, or science festivals, can support learners to build upon the intellectual, emotional, and cultural assets they bring to a STEM-rich activity or setting. As mentioned above, some researchers are now studying how children and youth do identity "work" (i.e., developing a positive sense of self in science as an active process rather than a passive or incidental outcome), and they are doing so in ways that integrate STEM identity with other identities such as gender, ethnicity, or culture. In this sense, a STEM identity can become an outcome of learning processes just as much as it is a component of the process of STEM learning. This also applies to adults who encounter STEM within the context of a science communication or informal science learning activity.

How is identity related to other constructs?

Finally, we learned from our interviews that identity is closely intertwined with interest and motivation, although they are sometimes measured as distinct constructs. While identity relates to how individuals think of themselves, interest can be more narrowly focused on the degree to which something resonates with an individual or captures their attention. The concepts are linked in that the degree of interest in a topic signals the centrality or salience of the topic to someone's identity. Conversely, a STEM identity influences the level of interest in STEM. The same holds for motivation: being motivated to engage in something (such as a STEM-related activity) is influenced not only by one's STEM identity and interest but also by a host of other, often highly situational, factors. An additional related construct that has gained traction particularly in the UK is science capital. While not explored in these pages, King's College London has developed a concise description.

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