



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.”

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.

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.

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Explore videos, interview Q&A, and resources from our interview series sharing diverse perspectives from scholars whose work focus on different aspects of STEM identity, interest, and engagement.

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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What is STEM Identity? An Interview with Edna Tan

On November 14, 2017, [Kelly Riedinger](#), Senior Researcher at Oregon State University's Center for Research on Lifelong STEM Learning, interviewed [Edna Tan](#) to understand her thinking and work on the topic of STEM identity. Dr. Tan is an Associate Professor of Teacher Education and Higher Education at the University of North Carolina, Greensboro. Dr. Riedinger conducted the interview as a member of the Center for Advancement of Informal Science Education (CAISE) task force on evaluation and measurement.

A video of Dr. Tan's interview, as well as interviews of other researchers, is available at InformalScience.org/identity.



Tell us about the project you've done that has focused on identity.

I've been working for the past decade with my colleague Angela Calabrese Barton at Michigan State University. And we've been using identity as a framework across probably four or five projects. All of our work are with youth from middle school, some upper elementary schools. So on one of the earlier projects, we were in a middle school in the Bronx, and we looked at Latina girls' identities in practice in sixth grade science. We followed them for one academic school year and then into the first quarter of the seventh grade. Our other project, which is titled "Clubs to school," we looked across settings. So again, girls of color in the seventh grade in an informal school science context. And then looking at them as they engage in formal school science. So we tracked the girls. This was a three-year project. We had two groups of girls and each were tracked for a year. We also worked with youth in informal settings at a Boys and Girls Club specifically where we run an informal weekly program that is STEM and maker-centered. So that ran for the past seven years, and we tracked youth, some of them as long as five years, just their engagement in these spaces, what kind of identity work were they engaged in. So we've been able to follow some youth longitudinally to track their identity work in STEM.

Across those projects, how do you define identity?

I think we found it more productive to think about identity work rather than identity and also identities in practice. So identity work we think is more productive because it's more active, and it also suggests that it is something that is fluent, and identities can be stabilized or destabilized through dynamic interactions with significant others in which we are performing the identity for. So the idea of identity I think sometimes can be taken to mean very innate and stable, that is sort of like an individual trait. We don't take that perspective completely. We think a lot of identity, and identity work is a negotiation with people in whatever space or figured world that we're in. So in thinking about identities in practice, the whole idea of practice, I think is really key. We've seen the youth perform themselves differently when the community of practice in which they are entering, and to engage in STEM in, has been different.

Can you tell us what “figured worlds” means?

So that's Dorothy Hollands's work, and “figured worlds” are her way of talking about a space that has its own norms and practices. So in our work in the middle school, we have talked about within a formal classroom space that you actually have different figured worlds in which the student has to perform differently. For example, in a small group setting when they are doing projects, versus a whole class setting when the teacher is driving a discussion. So I'll just use a case study: There was this girl, Amelia, in the sixth-grade science. In a standard of sixth grade in her school, which we can consider a figured world, she has the identity of being somebody who is aggressive and a bully. In a whole class-sized classroom figured world, her science teachers say that she is a bully, and the science teacher used a descriptor, that “she's on the edge.” So she could fall off any moment, as in she could flunk her science class. Whereas when she was in a small group with peers that she could work for, she was very different. She came up with ideas. She came up with suggestions, and she engaged pretty significantly with the content. So the rules of engagement or the power dynamics in these different figured worlds really directly affect how Amelia was performing herself. So that's what I mean by figured worlds.

And then we also have been recently more explicitly looking at the idea of intersectionality. You know, who youth are and what aspects of themselves they bring to STEM. And so, for example, we've seen in the informal makerspace, a STEM-figured role the youth tend to bring—and we encourage that, i.e., the whole idea of whole child and, funds of knowledge and community wisdom and to bring that into the discourses of science. So the youth have brought in issues in which they have been struggling with. For example, homelessness was one that came up pretty frequently unfortunately because the youth we work with often experience sporadic homelessness. The identity of being someone who experiences homelessness was performed in the makerspace, and that had informed some of the projects that they then engaged in. So there was this 10-year-old girl who was sporadically homeless and had some experience at homeless shelters that left her feeling very vulnerable that are related to winter clothing and being bullied for lack of fashion and, you know, being cross with strangers and feeling uncomfortable with talking to people she doesn't know. So all these ideas that are born from the identity of being homeless informed her project. She ended up designing a light-up beanie hat that was powered by a solar panel on the back. And then she embroidered a heart shape right on the front, and where the LED light was, there's also a button and a buzzer that you can press to call for help if there was somebody around

that was making you feel unsafe. All these different identities sort of intersected in this product that she made. And so we've been seeing manifestations of intersectionality and what that means for different youth because of the different identities in all the different important figure worlds of their lives.

Would you mind explaining what “funds of knowledge” means?

So [funds of knowledge](#) comes from [Luis Moll](#) and his colleagues, where they encourage classroom teachers to visit the homes of, I believe, their Hispanic students to understand the everyday lived experiences of these students and how those lived experiences are rich with knowledges and resources that can be incorporated into the discipline. And, a very complimentary idea that we draw that from is from [Carol Lee's](#) work. She talks about cultural modeling, and something that she's written has really stuck with me is that we need to figure out how to incorporate youth who are not from dominant culture their everyday experiences and integrate it into disciplinary core knowledge. So not just as a symbolic gesture saying, “oh, that's really interesting you did this at home,” but to think hard about how to use that knowledge and weave it into, either the performance tasks or the discourse in the classroom so that there's actually weight and real capital in what the kids bring from their everyday lives.

Why and in what ways do you think identity matters for science learning?

I think we're familiar with the achievement gap argument. And then there is also data that shows that achievement gaps are supposedly closing for some groups of kids and or across boys and girls. But then we also see that there's a persistent achievement gap in terms of test scores. And the other troubling phenomenon is that even when youth of color or girls, that when they make up the test scores, they are not pursuing higher-level STEM courses. So there's something else beyond what I can do on a test, right? And so we think that in addition to the achievement gap, which is one piece of data, we need to think about identity gap. There is an identity gap instead. So youth of color, women, and girls—and this has been shown—they just don't see themselves as belonging to STEM. There is a lack of role models. There's a lot of literature on that. And that the other piece that I think is interesting is that some of the role models who may look like youth of color, but from conversation we've had with youth, this tension that they think the role models who may be African American, for example, seem to have to become the “other” in order to succeed in STEM. So there's this conflict in “do I want to risk any erasure of who I am in order to be somebody in STEM?” I think it's more than just saying that look, we have STEM professionals of every hue and different gender, but also to look at the culture in the STEM professions and which dominant culture that really resounds with a particular group of people. So, to us at least, this is all related to identity and identity work, and it starts from upper elementary to middle school. Researchers say that 60% of STEM professionals decide that they want to be, that they want to pursue that as a career by the time they're 12 or 13. That is troubling to us to an extent and in thinking about what is the STEM pipeline, maybe we should think about a pipeline as a matter of fact, but maybe we should also think about pathways. But also that the issue of an identity gap should be something that is addressed right from the get go, at a young age.

There's a lot of ways that people approach identity, and we know that identity is very broad. How is your approach distinct from other approaches to identity?

I think our approach is similar to some other scholars in the field, which is identities in practice. It is socially negotiated. It is not an innate trait. And we are very hesitant, and I think this is connected to a question later on about the idea of measuring identity. Because in our work we've seen that it is very fluid and dynamic. I think we can capture snapshots of what the manifestation of a particular identity looks like in the moment in which we are taking that snapshot, but I do think that there are a lot of caveats in what we can infer from this snapshot.

You said that there's a lot of caveats—would you mind just explaining a little bit?

I think the affordance of using identity work as a lens, and seeing it longitudinally and tracking it longitudinally, is that we can see at different timestamps and in different settings the youth you can say is performing a different identity. For example, there's this girl that we've written about, Melanie. She's a sixth-grade Latina girl. She's very insecure with her English, but she's not labeled as an English Language Learner. However, in any other informal space, she would be speaking Spanish with her other Latina friends. In the beginning of the sixth-grade school year, she started to author this identity in practice of somebody who always passes, you know, she called it a game show rule. When the teacher asks her a question, she will pass, and he allowed students to pass. So then she became known as the passing girl. So her friends were calling her the girl that passes. What happened is that when she was in a small group setting, this is also in the first three months of the school year, other students were actively trying to trick her out because they didn't see that she was a valuable asset to the group—she didn't know any science, she passes all the time. So if we took that snapshot and read all the descriptions we would say that she is not a science person, right? But because we tracked her, and the teachers opted to put her with groups where her friends were there, the girls with whom she spoke Spanish and are fast friends with, these friends in that figured world started to demand that she participated. It could start with very small things, right. The teacher would often make them do some sort of chart, poster, or concept map, for example, the nutrient recycling and each of them would have a particular biotic factor to focus on. And they would say you need to draw the soil, and you need to color it, and you need to take care of that part of the poster. So it started with these kinds of, you know, we conjectured, from Melanie less threatening kinds of academic tasks. But then it progressed to where she was able to put up her hand and answer questions. This was much later on in the school year. So it's a completely different snapshot than what we would get then. And so she was somebody, a rule, you know, at different timestamps you would see that she is evolving and her identity is productive and positive, but it also was destabilized when the teacher put her back with the rest of the students who were less supportive and who did not demand her participation as much as her friends did. And then you think about intersectionality. We don't know how much of the friendship relationship, the supportive relationship that she enjoys out of the science context, is mediating whether she would feel that she wanted to take the risk or not. So all to say that at different timestamps, you know, students can perform an identity, you know, positive or not positive toward science. And if we don't track them across, it's really hard to say what's happening and who and what is supportive of a positive and a productive identity work.

So the caveats are sort of that you have to contextualize the snapshots?

Yeah.

We've talked implicitly about science identity, but some people also talk about a STEM identity. What do you think about that? Do you think there's such a thing as a STEM identity?

I think STEM is a really loaded term. And I think it is useful in the context of K-12 education for educators and administrators to lump these disciplines together. Because, yes, there are, obvious connections between science, technology, engineering, and mathematics. But one can also argue that each of these letters, in this discipline system, have very unique content knowledge and practices and [are] very distinct from one another. Depending on how the discourse is framed for the children and for the youth in the educational context, that if the science teacher who is an authority person uses the word STEM, and says that this is what we're doing in STEM class, and youth who are performing and creating the artifacts that are being supportive might articulate that, "yes, I have a STEM identity." But teachers who say this is a science class, they would say they have a science identity. So I don't know if there is such a thing as a STEM identity that applies across contexts. I think it's where the term is being used. And right now, I think it's more useful for teachers and educators, the adults who are engaged in the enterprise and not so much just student learners who will find this term useful to a certain extent. I mean, you take technology, is computer science even included in that? People have different opinions. I think it's very challenging to say that there's a STEM domain that I am equally engaging in science, technology, engineering, and mathematics every single time. And that's challenging.

How are you currently measuring identity in your work?

We're not. I think we wouldn't use the word "measuring." We would use the word "capturing" snapshots across time. But we have found that there are, what we term in our research critical science identity, artifacts. So these are either products that the children have made in STEM learning experiences or it could be a particular experience in which they engage. It doesn't have to be a material thing. But it could be a way in which they have engaged in STEM class that really resonated with them that they keep going back in their interviews, and when they're referring to themselves and how they are thinking [of] themselves as a science person or not; that they keep going back to that artifact or they keep going back to that particular experience. So we have reasoned it out that these seem to be critical science identity artifacts that start to solidify or laminate the productive identity work that the youth are doing.

An example would be this kid made a documentary in an after-school STEM program about greenhouse gases and then was really compelled by the work that he could do and brought the movie from the informal space to the formal space to show the science teacher. So for that kid in whom we would trace, that was sort of my pivotal experience for him, and the pivotal product that he made that showed who he could be in science. He was not the class clown all the time, it reflected his abilities and his potential. So we could call that a critical science identity artifact.

How do you collect data to understand students' identity work or to get at those critical identity artifacts?

We engage in ethnography, and most of the time critical ethnography, because we're really interested in issues of power and how systemic injustices intercept with local performances. I don't think you can run away from considering that. And so we embed ourselves for a long time in the field. So in the classrooms it will be two or three times in a week where the researchers there are collecting data in terms of field notes. But then we [are] also very happy to serve as co-teachers or co-mentors so that we really know what the norms of the place is. Because in thinking about identity work and identities in practice, I think it behooves the researchers to know what the norms are and what the culture of their space is. So we do a lot of hanging out in that space, inserting ourselves in that space and then following the youth in that space and across spaces when it is across settings. There's the usual repertoire of qualitative data collection methods, field notes. We also engage in sometimes videoing of the classroom when we have permission. And [there are] many focus group interviews, sometimes with teachers and students, sometimes only with students, and also one-on-one interviews with kids and teachers. So we have all that. And I think in one of the papers we wrote, we tried to dig a little bit deeper in narrative identity—how kids talk about themselves and what they think they are doing and who they think they are becoming or can be in a science setting. So that's narrated identity through interviews, mostly. And then we looked at embodied identity, which is what we see them being able to do and perform in these spaces and in the classroom or in the informal space. And we looked at the disparities between what they were narrating and what they were doing and how the community of practice at large influenced it.

So it's really interesting in this one particular classroom, just for an example. This is a sixth-grade classroom: two girls, one Asian American, one African American. [The] Asian American girl narrated a really positive science identity. She said, you know, "I'm gonna become a doctor for animals; I really love animals." The teacher loved her, she had all top grades throughout the year. And then in our observation of her, she would do her work really quickly and turn in the worksheet. Then she would get onto where the teacher has extra credit work. So her performances were all the good-girl student performance, whether it is science or not. This is just how she is. But, when we watched her, the teacher didn't do many hands-on inquiry-based STEM experiments, but when she did, it was interesting that this girl, who on paper and through and her narrated identity was so tip top and positive, she did not perform the practices of inquiry-based science. She was quick to make assumptions and to check her answers with the other smart people in the class that she has personally identified. She just wanted to do everything very, very quickly. The other thing that we have done is to have think aloud interviews with the students that are very much content-based. We would draw the scenario based on what is related to the content in the setting. We would ask them to think aloud about "what do you think is going to happen with scenario X?" And this girl could not answer the questions. It was interesting in how she was performing herself, which if you looked at the data, you will not say that she is really engaging in inquiry-based science. But when she narrates herself, and the teacher's narration of her, [it] is all very productive and positive.

So then this other girl, and this is an example of intersectionality, she was struggling really hard with formidable challenges in her home life. And so she was coming to school with the same set of clothing every day for months. And that presented a problem, in terms of bullying

and hygiene and all that. And so the science teacher who was a really kind lady, she collected money from the rest of the teachers to buy this student new clothes. But this student—at the same time as she was just being scripted as someone who was really poor, and we need to help her—was engaging in inquiry-based science. We gave the students disposable cameras, just like go and capture what you think is science happening in your home life. She was the one that was super excited and came back with many different pictures, and she would narrate what she was doing. She would ask questions during the times when they do hands-on stuff, in an authentic inquiry-based way, but she was unfortunately shut down by the teacher all the time because the teacher seemed to be foregrounding her as a *you are a student-in-need* identity, so those were the norms in the classroom.

The teacher didn't like them to talk loudly, didn't like them to keep putting up their hands to ask her a question like "can you come and look at what I'm doing with this experiment, this is what I'm thinking," e.g., the teacher wanted them to just write everything down and decide as a group what their final answer is, and then she would just check it off in the work; she would just not help. This student wanted to, and was able to do it. She was just really excited. So when she narrated herself, she talked about all the negative things: "My teacher is always scolding me; my teacher doesn't think I'm good in science; my teacher blah, blah, blah. I don't think I'm good at science." But, in her embodied performances, we think that she's one of the best in her class. She's always the one who's asking the really good questions. And then sadly, when the teacher looked at her test scores, the teacher was shocked that she was doing as well as she did. She said, "I would never have thought"—and this is the teacher who is grading all the papers—"that this student made an 'A' in my class, because of all the challenges I've had with her in asking her to be quiet and do her work." So there [are] all these intersections between a good student identity versus a good science-student identity. And parsing out narrative identity with embodied identities, I think we found to be illuminating.

One thing you mentioned was *critical ethnography*. Can you explain what that means?

Ethnography is a way of conducting research in authentic settings for lack of a better word, and it comes from anthropology, where anthropologists would go and essentially live with the group of people, a community that they are interested in learning more about. So we in the same way embed ourselves in the school. We're there a lot. We spend many hours in a classroom with the teachers, with the students. So to contrast that with a more drop-in or another approach in which, a large number of survey data is given to students via computer across many grades and then you analyze a large chunk of survey data, but there's minimal contact, face to face, with the students that you might be studying. Ethnography is very much focusing on and for long periods of time, a significant period of time, maybe a smaller group of people, to really learn about how they are engaging in this particular phenomenon, which is science learning in our context. And then criticality, critical ethnography, the criticality comes from acknowledging that this is connected to power. There's no neutral education. There's no such thing as neutral learning, there's always power involved. Some people have no power, some people have less power. And bringing that lens to the ethnographic world to reveal where are the inequities in terms of power distribution and how that might impact some kids' learning, and what we can do about that.

Do you think it is possible to create tools for measuring identity that practitioners or evaluators could easily use? Is it possible to develop practical measures of identity that can be used to guide program design or program impact?

I think the first step when we work with teachers is to introduce the idea of identity gap. That students need to actually author positive identities in science. I think that identity work as a concept, as a learning outcome, as a productive and essential learning outcome is pretty foreign to a lot of teachers. And so we've done some professional development work around that in one of our projects that we called [Recognizing Productive Identity Work](#). Everything sort of boils down to pedagogical moves and strategies. So some of the things we have tried out, and this is what is ongoing, is "what does it mean to value every day experiences that your students have and to bring those experiences authentically into the classroom science discourse?" I think a lot of teachers are familiar with science talk and science stories and asking students what have you done in your home and all that. But then they often stop. The kids share their stories, and then that's it. They'll move on with whatever is on the [pacing guide](#). So what we are trying to do—what the teachers get to say is okay, so you've done the story, which is great. How then can we read these stories and dig for more community relevance in their experiences to inform what they do in the classroom and what their final products might look like in a classroom?

For example, this sixth-grade teacher was teaching about the respiratory system, and diseases, lung diseases like emphysema, which is connected to smoking. This is in an urban district, and this is the second year in which the teacher has worked with us, so we had some of these PD talks with him. And so he decided that, as a final performance task for the unit, he was going to ask the kids to come up with a skit, which they would perform to convince people not to smoke. He just painted it broadly, "let's do an anti-smoking skit." And then he had some requirements that you need to show understanding of emphysema and the biological consequences of smoking. And he left the script up to the students. So what happened was that there were six skits in his classroom, and all of them were about easy access to cigarettes on two or four streets that surround their school. The students brought into the scripts which bodega you could go in where the owner would not bat an eyelid in selling you cigarettes, even though it's clear that you are too short to be smoking. And what it means when some of your friends who have dropped out of school or who had to support themselves. So there were a lot of kids who were acting as newspaper girls or newspaper boys, or people who are just helping in the bodega to make a buck or two and how their culture sort of intersects with early smoking.

So all these community funds of knowledge, and the things that the teacher didn't even know that the kids could bring in, were woven into the script of this performance task in science class that was then further dug into deeper in a whole class discussion. And that counted to us as a final grade for the students. That's just one example that we're trying to help the teachers to figure out.

A lot of it started with recognition. Recognizing that you can position all your students as competent in having something available to bring to the table, even though it might not be what you traditionally think it should be. And how you can progress as your lessons go from introduction to digging into the content, to assessment—how those threads of students' everyday lives can be woven into the process.

What about program evaluators—do you think there are any kind of tools that could be created that would help in measuring identity?

I think if I were a program evaluator, and I want to see identity work, which is my construct, I would probably tell the PI or the teacher to say, “okay, I would like you to at regular intervals, be it monthly or every fortnight, to have snapshots of the products that the kids are making. I would like to hear three-minute snippets of the classroom discourse discussion.” And then I would probably come in and have a focus group on narrated identity at least—how kids are thinking and talking about stuff.

The other challenge is that for young children, especially upper elementary, it’s very hard for them to talk about identity because it’s a difficult construct, right, even for adults. And how do we help them? So this is like in research methodology, and how we help them to articulate and think about how to give us ideas of how they are thinking. One of the things that we’ve done is just to ask them on a scale of one to seven, “how would you rate yourself, in your science class and why?” A lot of times, kids would rate themselves [as] “oh, you know, I’m a three.” Why? “Because I just don’t talk in science class, I get really nervous, blah, blah.” And then we would follow up and ask (and this is usually done in focus group) the peers: “Do you agree that Anna is a two in science class? Why or why not?” And then that usually brings up really interesting contradictions that tell us something about how the kid is maybe conflating different kinds of identities together. We would do that on a regular basis just to check how the kid was changing and how their friends are either corroborating or bringing up other kinds of data points that we can then go back and either look at classroom videos to see how this kid was performing at this point in time, as triangulation. So if I were a program evaluator, I would probably ask for those kinds of data sources and also look at those data sources across students; students who the teacher say is high ability, low ability, however they define it; medium ability, and then across ethnicity or gender.

A lot of people are talking about things like interest, motivation, and attitudes as outcomes for science learning. How do you think these connect with identity, if at all, and how do you distinguish science identity from these other concepts, if at all?

We’ve thought a lot about this. I think because we take a sociocultural and sociohistorical view of identity focusing on identity work and identities in practice. I think the descriptions or labels or constructs such as interest, motivation, and attitude are manifestations or markers of a student’s identity in practice in the moment when attributes are captured. So if I took a survey today and you ask me about my motivation, one to ten, about doing well in science, that’s how I’m thinking or how I’m feeling at that moment. I see them as indicators of a moment and that they are fluid and that they can change depending on the students’ ongoing negotiating about their identity work. I do not necessarily think that there’s anything completely intrinsic or innate in these attributes located in the individual, but it’s very interesting in our interviews of students that the students themselves, in the discourse that is more commonplace, that they latch onto these ideas of, e.g., Sammy is a science person, Sammy is so smart in science, and Sammy is invariably a white boy. And so they latch onto this individual attribute, especially when, you know, the classroom is traditionally constructed. So we think it’s a descriptor. Even in identity work construct you can say, at this moment, Melanie, when she is with her close girlfriends in a small group, is highly motivated

to do the work and highly interested in work. But when she is with another group of kids who tend to bully her, she is not motivated, and she is not interested in work. In that instance, personally, I think it is a snapshot and again, there are limitations of that snapshot.

What are some examples of resources or tools for measuring or understanding identity that you have found useful? Are there some people or projects that you would recommend that are useful for thinking about identity?

We're not measuring. I think there's a lot to understand, explore, and name in terms of identity work that requires longitudinal embedding in the field. I think unless we understand the norms, the practices, the power dynamics in these spaces and what is supporting or not supporting kids in engaging in productive identity work, then it's more difficult to have recommendations. Because if we don't know what is supported, in terms of pedagogical moves, [this] could be as mundane as how we group students. [It] is difficult to get kids interested when they're not interested for various historical reasons, especially for historically marginalized kids.

People whose work that I found useful, of course, [Angie Calabrese Barton](#), her work since the nineties, and she's worked with homeless youth across settings. I think [Megan Bang](#) and her colleagues work with Native American youth, indigenous youth, in figuring out and really making visible the rich sources of community knowledge that is so grounded in science that has just been blocked because of the dominant culture in science—I think has been really helpful to thinking. [Maria Varelas](#), who does work with her colleagues in elementary school students, African American students—I think that's been helpful. [Na'ilah Suad Nasir](#), she does work with looking at learning environments. She and her colleagues recently had a [piece out in the Journal of Learning Sciences](#) looking at mathematics and how African American boys engage in mathematics and how mathematics experiences are racialized. So again, highlighting intersectionality and why we need to look at that. And my colleague at University of North Carolina, Greensboro, Heidi Carlone, and Angela Johnson, her colleague, they have also done interesting work looking at identity at the college level. They have worked with women scientists either at the university level or graduate level, or even the professions to see why it is that these women persisted. And a lot of the things that they found out I think resonate with the productivity of thinking of identity work because of this whole slew of supportive relationships or experiences that we've had that kept us going. And even then, there is this big problem because we know that women tend not to remain in the field, even after they put in 15 years of their lives, to get the required standards and qualifications. Once you are in the field itself, it's still so hostile towards them as women scientists and also to minorities. I think that is an impetus for us to really seriously think about that it's not just that we want more girls, black and brown, children to engage in STEM so that they will think about pursuing STEM. But it is really a disservice to have them do all that work and then go into those fields and then decide that, no, I am going to have to give up my whole entire other personality to do this work. I don't think that it is very productive in thinking about how to expand the STEM professional pool to be more inclusive.

Is there anything else about identity and science learning that you wish to share?

I think identity work is key in supporting students to engage in science learning productively, and I think, to quote [Gloria Ladson-Billings](#), we have accumulated considerable “education debt” to our low-income and youth of color, and I think that a lot of that debt is connected to not focusing on identity work, thinking about who the youth are and who they can be in science class. And who they want to be, in science. So these are questions that are not necessarily considered, and should be considered as a cohesive suite of what are expected learning outcomes from science. I think we need to keep pursuing identity work and to understand why there is such a large identity gap between youth of color and white youth, and between girls and boys.

What is STEM Identity? An Interview with Shelly Valdez

On July 17, 2018, [Jamie Bell](#), Project Director and Principal Investigator of the Center for Advancement of Informal Science Education (CAISE), interviewed [Shelly Valdez](#) to understand her thinking and work on the topic of STEM identity. Dr. Valdez is the President of [Native Pathways](#), a consulting company with deep expertise in science education and indigenous evaluation processes based in central New Mexico Laguna Pueblo. Dr. Bell conducted the interview on behalf of the CAISE Evaluation and Measurement Task Force.



A video clip of Dr. Valdez's interview, as well as interviews of other researchers and evaluators, is available at [InformalScience.org/identity](https://informalscience.org/identity).

The National Research Council's 2009 report, [*Learning Science in Informal Environments*](#), stated that one of the things that people can do in informal environments is to develop an identity as someone who understands, uses, and does STEM. Since then, people have been designing projects, settings, and activities with the goal of helping people foster a STEM identity, or recognize a STEM identity that they already have. Knowing that you have worked with a number of National Science Foundation (NSF)-funded projects as an evaluator, and in a range of different settings and such, how do you think about identity from an evaluation perspective?

That's a loaded question but a good question though because I'm thinking about my involvement in STEM through the lens of this particular project that is focused on native undergraduate and graduate students in higher education. These students mostly come with a grounded understanding of their culture and living within those communities. And most of them that I have interviewed don't have a solid base of their language, though. So the languages that they're organically growing through this process of being engaged in an environment with STEM (and technology) is highly saturated with traditional ecological knowledge. Their science language is growing.

I always remember a focus group interview where each of the individuals, when I asked what their understanding was now that they were in this program for some time and immersed in TEK [or traditional ecological knowledge], what they felt about the knowledge base of TEK. It was embedded in their culture, and they didn't realize that there was a [separate] term for it or realize that that's what they were doing until they got into higher education. So with that said, their identity is internalized from a cultural lens; but when they got into the university science arena—the “western” science, they started learning all this science language that has shifted their thinking about TEK. In talking to them from that preinterview to where they are now, the language of [western] science was really prevalent. They were building their language skills, which means that they were creating their own unique identity of what science means to them from a traditional lens, and now deepening this understanding from a western science lens. I think [identity] it's individually based, because it's not a culture. It's not a culture that they're born into, it's a learned understanding. Through these students understanding, including my own, we're learning science identity in so many ways from that cultural lens, we just don't call it science identity. We don't have a term for science, it's what we do, it's our ways of knowing.

If I understand you correctly, for native youth or undergraduate students, in some ways STEM being part of one's identity is probably already there. It's part of an understanding of, and a relationship to, the world that isn't called out as a separate thing.

Right. It isn't defined by western wording or western understanding. It is defined and embedded in their languages, in their culture and their environment; it is the notion of being grounded in “place.” Even though they were separated somewhat from their language, it was still very active within that environment. And I think that for native, indigenous people that's explicit. We don't have any words that we call research, all the wording that you find in STEM, in a western institutional academic institution. There's not really any terminology in indigenous language, it's just the way of knowing, which is very deep and poetic if you truly understand. And I think that researchers and evaluators really need to understand that. When you ask a native student or person this particular question about identity, well it's who I am and is there a science identity? But it's a chance for them to rethink about their language use. And as I mentioned before, in pre- and postinterviews these students understood it as a way of knowing, while over time you can see the growth of western science literacy. I wouldn't call it a separate identity that they're building, they're just building their language. And so maybe there's a different word for that type of concept. I think it's embedded, and it depends.

Is there a concept, in the native language, of someone who is a science person or a music person or an arts person or, i.e., you're more oriented towards a certain topic or discipline? How does that manifest in these cultures?

Certainly. A lot of the buzzwords and processes that are used now, and for centuries in education, and the strategies for educating individuals lend themselves to that native understanding of “education.” And I'm using quotes for the word “education” because again that's not a word in most native languages—it's a process in a deeper sense, but part of our

ways of knowing. It's my understanding from working with different tribes that a lot of them have what you, or western education, call apprenticeships, and that was their way of educating and grooming youth to learn a particular knowledge system. There are some tribes that continue this "education process," that have specialized individuals who are groomed to embrace this specialized knowledge that nobody else is privy to. Some of them are born into these environments, and some of them are selected or volunteer for being a part of those environments. There are different systems within those cultures that align themselves to what you would call a particular content area in academia, and so from early on they're groomed to take over the leadership of that particular environment or function.

Many tribes that I've worked with do have such individuals that are specialized. I'll give an example: You have what researchers call sky watchers, in archaeoastronomy. Those are specialized individuals that have this deep knowledge of how the earth, the universe, and the solar system work with one another. They have this implicit understanding of the earth's movement and the sun and the moon in relationship to that movement. The textbooks and academia refer to them as sky watchers, or archaeoastronomy researchers. But tribal communities have their specific names within their own communities that we refer to them as well.

So, youth who are growing up and going through an educational process, some might be attracted to a topic and then through an apprenticeship model would learn expertise?

Yeah definitely, that's one way. I'll give you an example. I just finished with a project with my colleague [Dr. Isabel Hawkins](#) from the Exploratorium called the [Yakanal Indigenous Youth Culture Exchange](#), with traditional farmers.

A few of the youth that we worked with grew up outside the community, so they weren't able to access this rich knowledge from mentors, the grandfathers, the uncles growing up to learn the process of traditional farming. And it's different from mainstream farming. Many of the Pueblos—there are currently 20 Pueblos that still exist today, and they are each separate tribal communities—have dry farming systems, so you have to have the knowledge of the environment and the soil and the landscape and really be aware of those systems that are going to affect growth of the corn or other crops planted. Also, the corn is very different. You have to know your corn, your seeds, and you have to talk to them so that you can create that relationship with those seeds. There are individuals that steer themselves to that knowledge, and there are some individuals that will say, "Wow that's really a hard thing to do, and I don't think I'm that person to be in that environment." So they take a different route. So, you know, it's dependent on their interests.

In all of the projects you are either currently working on, or have worked on, which one would you say involve[s] identity as a component of the learning?

I have to say the Yakanal Indigenous Youth Cultural Exchange, because it moves itself away from that western context of thinking, and while it's still present, it's minimized. So that these youth that we're working with can dive into reigniting the spirit of their language and culture and reactivate it. They have a craving to and want to learn about who they are. And that's identity.

And who they are is important because it's in their DNA, they can't deny it, because we're born into these beautiful indigenous communities. And unfortunately, some individuals don't have those opportunities to grow up within that rich environment for whatever reason. But these are youth that have that explicit yearning to want to re-engage in that deeper understanding of their culture so they're looking for their identity. They're wanting to strengthen that, and so the beauty of it is it's in our DNA. Science is in our DNA, we are science. And so everything that our cultural ways of knowing and being, if you study it very closely from that western lens, you will be able to see and pull out the science.

But you have to spend time with them [the youth] creating that relationship to understand that deep knowledge. And that's what we're trying to do, is create that leadership for these youths so that they feel okay, they feel pride, they feel ignited about their culture and their language, and therefore they're able to navigate these systems that are a part of our environment now and know that they can feel good that they're grounded in who they are.

For me, that would be I'm *K'awaika*. I'm not American, I'm *K'awaika*. *K'awaik* is the place. And I'm *K'awaika*. I'm "of that place." *K'awaika* is—if you translate it in the word that is on the map, it's Laguna Pueblo. When the Spaniards came over they interpret[ed] it as a lake, and they said "Aha! Laguna." So they named us Laguna. They also named our villages "pueblos" because our architecture is built around communal dwellings as opposed to being spread out by location.

I didn't know that history.

Yeah, so *K'awaik* is the place. Just like you're living in the eastern part of the U.S., you have a huge part of New York today is *Akwesasni*. It's the place. *Akwesasni* is the land, and *Hodaneshoni* is the people of the land. So those are identities. That's an understanding of who you are within that environment.

The Cultural Exchange project—what are the settings where that project is taking place? Is it in an out-of-school environment?

Oh yeah, it's all informal (pun intended—western education calls it informal). It's done within the homelands of the students we work with. For instance, we work with the National Park Service here in the Southwest, Chaco Canyon, Chimney Rock, Mesa Verde. We take them home first—to where their ancestors' land base was thriving, and those are those places where traditionally they had trade systems from our brothers or communities to the south,

Mesoamerica. And there's evidence that trade systems existed, so we start off there, and the equivalent in the Mesoamerica communities. After a particular length of time spent immersed in their ancestral homelands, then we bring them to the present-day native communities that are associated with those places. And it's all again just springboarding off the science of the land or "Science of Place." So we really explicitly try to honor that relationship to the land.

One question about another specific project from some of your previous work: The [Roots of Wisdom](#) project? Does that one involve identity at all?

Oh yeah. We had engaged several native communities, and the focus was on restoration. Restoration of cultural knowledge, environmental cultural knowledge, and so it gave each of the communities that we worked with an opportunity to either revive or reignite some specific knowledge system within their culture. The purpose of that is to, from a funders' lens, to collect data on this knowledge system and whether or not it's possible in this day and age to do that. But the real deeper purpose was to reignite that knowledge within the community. I'll give you an example, the Cherokees from North Carolina, they have reeds that grow in the water that really lend themselves to purification systems of cleansing the water. The reeds were naturally growing in the area, but they also used that cane to create baskets, and they were losing that knowledge—number one of the baskets and number two because of the forest systems cleaning out those rivers, the river cane didn't serve a purpose anymore for the community. So what that community is doing is bringing back the river cane, number one to serve the purpose and to help with water restoration. They're re-creating that relationship with the water, but they're also helping build a desire and an interest to going back to use river cane to create baskets. It's beautiful because now you can go to Cherokee, you can see that there's a growth in basket makers from this particular understanding of the river canes and bringing them back, and reigniting their spirit, part of their identity as Cherokee. And the river cane is there for that community to reignite the basket makers. As my son puts it, "It's learning from our oldest teachers, the plants."

What evaluation methodologies were you using?

[Jill Stein](#) and I have been collaborating for about 13 plus years. And we're growing together, and we call this concept [collaborative evaluation](#). Jill comes from the western context of evaluation, and I come from that indigenous processes used in evaluation. There's not a model, it's just explicitly a process because we're working with so many tribes, it's dependent on the environment were in; you can also refer to it as emergent evaluation. It doesn't mean that there's a framework, it just means you're being very careful while "walking through" evaluation. Because there's a history of trauma from researchers and evaluations with indigenous communities, when you walk into a tribal community and say you're evaluators, they're like "Oh," and it closes down. I'm finding out that we need more native evaluators.

We need to change the word evaluator to storyteller. We just call ourselves storytellers. Because that's very natural. We're here to tell their story. Research hasn't been so welcomed because of the past histories in indigenous communities. It's just walking together. And when

Jill has a question, I'm there to help guide that. And creating a relationship, so that tribal community members see that we're not a threat, we're here to tell their story.

What kinds of activities are you doing to elicit the stories from participants? Are you doing interviews? Are you doing observation?

Oh, yeah. So I love our process, but some funder's priorities don't align with our process. Because it's all relationship based, and this takes time, which is [often] way beyond the scope of funding. It's all about understanding and respecting those individual communities' core values. In order to do this, you need to create relationship first.

And there's some general core values that cross within indigenous communities, and there's some that stand alone. I can give you a few snapshots of core values that are generally within most native communities: love, compassion, respect, reciprocity, these are deeply embedded in most tribal communities. You have to love yourself, you have to love what you're doing, you have to love the earth, you have to love your environment in order to have those deep relationships. You have to have compassion for everyone's worldview and for that individual that you're working with—if they suffer from something you have to be willing to reach out to them; this affects their work that they do. Really understanding those and being respectful of those is key. Then you also have to be willing to step outside your worldview and dive into their [others'] worldview. So that means you have to spend a lot of time creating relationships before any of this work can start. And relationship doesn't come overnight. That's where we kind of have a challenge with our funders.

Relationships you have to build, so that they can trust you to tell their story. And right now, a lot of tribes, like I said, they don't trust individuals that wear this research or evaluation hat. They close off. But we're learning also that because I'm native that there's a little bit of trust. Not much, but it makes a difference.

What we use is participatory process—one that is important for us to engage. I have this great story about a project that wouldn't allow me to do this. It was a native project that was run by [a] non-native person, and they would not let me engage. They saw evaluators as, you know, this outside entity—with characteristics like being detached, independence, neutrality, objectivity—and it was crazy. Anyway, we got through that. But, it's an example of what didn't work, and so I couldn't tell the rich story. I told the story of the surveys and observations of certain events, but nonetheless I wasn't able to create that deeper relationship, particularly with the team. So participatory evaluation is the process that's most important. And to get those vignettes that you don't necessarily find in interviews or surveys, you gotta be on the ground creating that relationship with those individuals.

We're moving away from focus groups and styles of questioning. We started off with the art of questioning and being careful about how we're constructing the questions that we're going to use. And [while] stepping back and analyzing this incredible data, the richness of the stories that we're being able to tell, even the notion of questioning can be pretty scary. Some tribal communities have, for lack of words right now, taboos about questioning.

You know, that you shouldn't be questioning and you shouldn't question to go into places that can take you in the wrong direction. That's a deeper knowledge system that someday I can share. So how do you engage these individuals? What we're doing now is we're taking our questions, and we're turning them into invite statements.

They're statements, basically statements, and we can share with you some of the work that we're doing now with that. We take the question, we work together and develop the evaluation questions, and then we morph them into statements or invites, so that it's less threatening. One of the notions within indigenous communities is that when you're invited in by those individuals and welcome them, that's where that notion of deep and genuine relationships emerges. So taking that same concept and notion of *inviting*, that's what we're using. In other words, we'd like to invite you to share some experiences with us in this particular environment.

That's a very nice concept.

Yeah. It lends itself a little bit better to those knowledge systems.

And then people respond to statements rather than to questions?

Exactly. And then we're also learning that, you know, evaluation sometimes is just rigorous, where they have a protocol of questions, and so the evaluators [are] watching the time and say, "Okay, well, let's move on to the next question." And so they don't stay with the flow of the conversation or the story.

We're also morphing that as well. Evaluation questions are just a guide, and if the story is rich, and it's inspiring people to share, don't break it. Don't break that wonderful flow. We're both learning this, how do we create that continuous process where that flow is natural, and it's not distorting the rich knowledge that they're [the interviewee is] trying to share. This process is what we are calling "Talk Story."

So, if you break it up you're going to miss a lot.

Yes. We're there, we're committed to telling their story because we created relationship. Early on our strategies did have the questioning. But what you're gonna see now, as we move forward, is that process of using the statement. So it's going to be interesting how Jill and I move together within that environment. That would be one thing to watch. We have a [report from Roots of Wisdom project](#) that describes our process and has reflections on collaboration with integrity. We also did a presentation last week that we can share.

Do you have any advice for researchers and evaluators?

Here's some general advice: Be careful about the questioning that you use when you engage with various projects. You're questioning—the art of questioning needs to be very carefully looked at and maybe not moving away from questions that put up shields or walls, and instead consider more of a statement or invitation for program and project participants to engage in the conversation. The other thing with identity is, you know, I fully respect those individuals that are storytellers and that are involved in these projects that we work with. And allowing them that space to tell the story is really important. So, in working with communities, try hard not to be that “western” evaluator or researcher that is not fully engaged but is only interested in the responses of the questioning process and the time.

To let go of that notion of time, because it can really defeat what it is you are tasked to do as an evaluator. Another area, looking at funding for evaluation that lends itself to this type of process is really important. Also, being mindful when you're creating proposals to look at what you're putting into the evaluation budget. That's important.

Because you want to create relationship with these communities to really understand them, so that you are better able to tell their story. The words that some participants in these projects and programs that we work with have explicit understandings that are really deeper than what they're saying. And when you write it into a report, I would be careful about, what did they mean by this? What did they really mean? Sometimes that means you do have to have a person from that community on your evaluation team to help you with that understanding because these are internal knowledge systems that have core values—those general knowledge systems may be a little bit confusing to understand through a western lens. But if you have a relationship with an individual that is a native person, and it doesn't have to be an evaluator, maybe a mentor or someone that you can go to to get this understanding, it's important. So, the projects that we've worked with that are NSF-funded projects, we have evaluator advisors. If I'm not available, Jill can go to our advisors. It's important to build in advisors who can help with understanding identity in these contexts.

Identity in the area of science for projects that are targeting native communities, you need to work with a partner that's either indigenous or who has some history in working with these types of projects, so they can mentor you. Having a mentor or a partner that can really help develop this proposal but also help develop the activities that will lend themselves to that better relationship, with a better balance, so that identity from that native worldview is really evident within those project initiatives.

And, I think we need, and I've been saying this for the past 15 years working with these projects, as individuals in STEM, I think we really need to take a look at some of the language that we're using that doesn't necessarily lend itself to native epistemologies.

Maybe we need to rename the notion of what an evaluator is. There are words within science education that don't lend themselves to that way of knowing and those communities' epistemologies. Because that historical trauma I mentioned earlier is very prevalent.

So how can we in the STEM field—as educators, facilitators, or partners—start moving towards better or stronger or more friendlier language systems that really create that balance and relationship?

Because evaluation can be a poor term for something that I think is much more natural and organic, which is just monitoring your progress as you master something, right? You're trying to learn a skill or an art form or whatever. And of course, along the way, either you or your teachers or whoever you're apprenticing with is helping you understand the progress you're making.

Right. And I think that we just call ourselves storytellers and that's what we are. We're telling their story, and that lends itself to a very native worldview.

And does the story evolve as the person grows?

Oh yes. That should be the case in any project that you work with. Like the example I gave you of these students that I worked with and how their science language, their literacy skills in science, are definitely growing from that western context.

But their knowledge systems and cultural language are also growing because now they have opportunities to learn the language and ask the elders for permission to share their knowledge. So that for a particular phenomena—say they're looking at bicultural restoration, and they're looking at a plant system that is being impacted by climate change—they have to go to their elders in their home to learn these stories about that particular plant and how it lives within the environment, and how the people take care of and use that plant. Through that whole process that individual is learning traditional knowledge but also learning—very wonderfully learning—their language for these systems in these environments. So, it's a win-win situation. They're building these two very different but very similar knowledge systems together. They're becoming more attuned to western science in the academic sense, and they're embracing and reigniting the cultural and language part of who they are.

I think what I'm hearing is that another way that identity manifests is in a story. If you think even yourself as a learner, as a growing person, your identity is a story you have about yourself and your relationship to nature and your community.

That's exactly what it is. I am who I am because of my relationship to the land and my relationship to the people—"the people" meaning my traditional community. I'm very proud, extremely proud, to be *K'awaika* and to come from *K'awaik*. I've been blessed, and I was gifted into this wonderful family that just happens to be native. And because of that, and my parents desire to bring us up in the cultural environment, I have an explicit relationship to my community, and I've been given a chance to learn that knowledge. It's up to me to engage. I've also learned from that western academia side that I've gone through for another level of education. I've been given an opportunity to work alongside some incredible partners and to learn from them. Learning will always be a part of everyone's life. It's up to you how much you want to engage in that learning environment and to strengthen those knowledge systems within you that go back to who you are as a person, and that's identity.

What is STEM Identity? An Interview with Jacque Eccles

On October 16, 2017, [Martin Storksdieck](#), Professor of Learning Sciences and Policy at the University of Pittsburgh, interviewed [Jacque Eccles](#) to understand her thinking and work on the topic of STEM identity. Dr. Eccles is a Distinguished Professor of Education at the University of California, Irvine. Dr. Storksdieck conducted the interview as a member of the Center for Advancement of Informal Science Education (CAISE) task force on evaluation and measurement and co-Principal Investigator of CAISE.

A video of Dr. Eccles's interview, as well as interviews of other researchers, is available at [InformalScience.org/identity](https://informalscience.org/identity).



Tell us about the projects you've done that focus on identity.

I would say that I've been studying identity for the last 40 years. I haven't always used that term, but I think that's the essence of what we're studying. So what we've done in each of our studies is to look longitudinally at how children come to see themselves as being capable of mastering math and science and the extent to which they want to do that. And part of the extent to which they want to do that has to do with how close they think science and math is to whom they think they are or want to be.

How would you define identity?

I think identity is very hard to define. I would probably avoid trying to define it in any one particular way. I think the essence of it as it's being used by people who are talking about science identity is that one can imagine oneself being a scientist or being a mathematician or that doing this activity is so much a part of who one thinks one is that it is nested within this thing we would call self-concept or identity. Now, I think people have many identities and these are all those aspects of their lives that are very central to what a psychologist would call their self-concept, who they think they are.

There are other identities that people have like gender, race, or other kinds of forms of who they think they are, and they might overlap with science identity. What role, if at all, does this intersectionality play in your work?

In my work, when I think of something like identity and use terms like that, I'm trying to understand how these mental representations actually end up affecting behavior. So the decision, for example, to take a math test or a math class or to go into a career that involves mathematics or science, I conceptualize it as having the attachment piece, which is how much of this is like me. But then there's also the extent to which whether I want to become like that, and that's where it will overlap with other identities. For example, if I have a strong gender identity, I have images of what it means to be, for example, my gender identity would be female. I would have ideas about what it means to be an ideal female. Part of those would be things like femininity, but part of those could also be things like what kind of work I want to do. And it would interface with the science identity to reinforce it to the extent that I think being a female is compatible with being a scientist. And that would have to do with the images I have of both of those identities. For some people, when you say I'm a scientist, they bring up in their mind Madame Curie, and there's no conflict at all between being a female and being a scientist. For others, that isn't the image of being a scientist to them, and therefore they might be in direct conflict. It would also have to do with things like, "well, what do I want to do with my life? And, if part of my being a woman is that I want to have children, I want to help people, I want to be altruistic, I want to be noncompetitive." Then if I believe science will inhibit any of those things, then I will keep those two images quite separate. But if I have an image, for example, that I can become a biologist, and I can cure cancer, and I want to do things to help people, then that's part of my female identity, then those things are completely compatible. So when I think about them, it doesn't have so much to do with whether I endorse the term science identity or feminine identity or femaleness, it's the content of those that matter.

Why and in what ways do you think identity matters for science and learning or science communication?

Well, learning and communication are two different things. I think that within my frame, which is an expectancy value frame of task choice. So I break it down into two components, both of which are part of identity, in my view. How good do I think I am? Meaning, can I succeed at this task? And do I want to succeed at this task? And it's where these two things come together, and they become central to my core self, I think you have a positive science identity. And if you have those things, then stimulating a science identity in a person's mind will stimulate these same things. Oh, that means I get to do something I like to do, that means I get to do something that I think will further my goals for myself that I want to be—I want to learn, I want to work hard in school, I want to learn the things I need to do in order to help other people, and so I will engage this task even if in the moment it's boring or difficult. This essentially provides a reason to engage the task. And, of course, the more you engage the task for personal intrinsic reasons, the more you will be able to stick with it even if it gets hard, frustrating, or you get anxious or other kinds of things that you have to give up something else you love like going out with your friends. I mean, you have to sort of think about what's competing for a person's time and how does something like an identity increase the value of doing this as opposed to something else.

This is a great example. And it's a great foundation for this idea of persistence that people are throwing around, right?

Yes.

But it also brings up the idea how your concept or your view of approaching identity might be distinct or different from other approaches.

Well, I think what's different in ours is we try to go into the mechanisms. So we try to go into well, all right, so you have an identity. Why should that affect anything? How does it affect it? And it affects it through motivation, and it affects it through the relative strength of motivation for one activity versus another. So I'm going to do my science in school rather than talk to my friend because that's more important to me. That's more central to who I am. So I think the term "are you a science person?" is actually a quick and dirty term to summarize a lot of underlying complex psychological processes. And I think we differ in that we focused on the side these more embedded science processes, psychological processes, than if you just use this term. I think if you just used this term, you don't really know the mechanism by which it's actually influencing learning or engagement.

Does it make a difference whether you call it a science entity or a STEM entity?

I think it makes a lot of difference because science isn't one thing. And, of course, it may start out for a young child being science, but somewhere along the way they're going to learn that there's physics, there's chemistry, there's medicine, there's biology, there's social sciences. Those all have very different implications for how they spend their time. So, for example, I went into microbiology when I was an undergraduate, because I wanted to help the world, I wanted to get rid of diseases and physics had no interest to me whatsoever. So I avoided physics classes. My identity was not this abstract notion of science at all; it was microbiology. And then it shifted to psychology because I thought, well, I really wanted to understand people. I understood that was equally important to saving lives. You work on it, but even if you get the vaccine, you're not going to get them to use it unless you can deal with the psychology. And so I shifted, and I began to think of myself as a psychological scientist. And I didn't define it as a social science. So in my mind, it was always an experimental science grounded in the natural sciences, never in the social sciences.

How do you currently measure identity in your work or have in the past?

We measure it very specifically. We measure it in many ways. We do ask people the extent to which they identify with science. And then we ask them the extent to which they identify. Because I use children and adolescents, I try to come up with pretty concrete ways to do this. So for example, we might use something like the implicit—the IAT where we would have a person and you would be measuring their reaction time to "is this like you or not like you?" I would show pictures of a scientist, and they would pick it. And I would show pictures of a doctor, and I would show pictures of the various things that you can depict, you know, pictorially so that the kids have an image that they're actually seeing. Or I might show someone working with test tubes or those kinds of things, and I'll see the speed with which they respond, which tells me something about how accessible the connection is between that image and who I think I am to the person. So the faster you do it, the argument is, the more

likely it is that that you identify with it. That you, at least, have thought about yourself in light of that image enough that you can get a fast response time. So that's one way to get it at a very nonverbal level. And I would do that with people, but I would also use a scale, how often do you think of yourself as a whatever it is that I'm interested in, whether it's a scientist or biologist or an astronomer or any terms that the children will understand what it is I'm referring to. Now, having done that, I then would also ask self-concepts. I would ask, how good are you at tasks like this? Not good to very good? What is the problem, how likely do you think it is that you'll be able to succeed at hard problems in this area? Very likely to not very likely? So I would get a set of questions that have to do with the person's assessment of their competence relative to themselves, to others, and to other subject areas and the importance that they attach to it. So I would say we do this. How important is it for you to do well in? And that would be the name of the courses that they're in; if I'm interested in particular courses. I wouldn't say science courses, because I think that's too abstract. What I would say is, how much do you enjoy doing the things in the course you're taking now? How much do you imagine you will enjoy doing the activities that you will be doing in your biology course next year? If you were to go to an after-school program that had activities like this, how much do you think you would enjoy doing them? So I try to get enjoyment. I try to get importance, and I try to get some questions about how much would doing this further the goals you have for yourself? So will what I learn in math help me to meet my goals? And we can get very good questions, two or three questions of that type produce very high alpha on scales. Kids are very good at answering those questions all the way down to fourth grade and maybe even younger. If we use pictures, we could get it at first graders. They're differentiated from a very early age. They're already able to tell you these kinds of things at a young age.

You've given multiple ways to measure that very independently. To what degree are these different approaches towards getting subcontexts of what you don't want to define as a full identity? How much do they overlap? How much do they confirm each other, or how much do they measure separate components of some larger concept?

We don't know the answer to that question.

Do you correlate these different approaches when you do the Implicit-Association Test?

Yes, they are correlated with each other. Sometimes they're so highly correlated, you wouldn't want to put them into the same regression equation. But within my theoretical framework, they tend to come together as they get older. The more central identity gets to a person, the more likely their values and their self-concepts are going to be highly correlated. If it's not particularly salient to their identity, they may, in fact, say I'm very good at this, but I hate it. In which case you wouldn't get a high correlation between the value being attached to it and their identity.

And we've started using approaches where we look for patterns. I would take all these different ways as essentially being a way of triangulating in, if there is way, and I don't know if there is. I'm a psychologist, I tend to break things apart. And I don't know if there's an aggregate that actually exists in a person's head. If the aggregate that exists in our head is a

theoretical higher-order construct. But we've started using pattern analysis. So we would take all these different measures, get them on the same scale, and then do pattern analysis and look for the people for whom they all go together and the people for whom they go together in different constellations. I would argue that the person for whom they all go together, who endorses all of these things very highly, is going to be the one that will go on and become a scientist. This other person over here who maybe really loves it, but doesn't think they're particularly good at it, but sort of thinks they see themselves that way, they may, in fact, become an amateur scientist. They may be a person who they're not going to try to make a living at this because they don't think they're going to be the very best at it, but they will enjoy doing it all of their lives, and they will stay engaged, and they won't be afraid of science. So when they say I'm a scientist, they mean something quite different than the person who is going to go on and get a PhD and spend the rest of their life doing science. I don't know where a science teacher would fit in this particular category. It would be very interesting to see whether people have a different identity for being a teacher of science than for being a scientist. Those are subtleties that actually would help us understand the particular ways people engage science as they move through their lifespan.

That makes a lot of sense. We're trying sometimes to distinguish a learner of science, a STEM identity, from more like an attitude towards science.

Right.

That makes total sense. So for you, the idea is that these things are components to this that have different predictive value.

That's right. And the value will vary across people.

Yes.

So I come back to this—it's at the personal level that it matters. It's not at the population level. So I get quite anxious when people throw all these things into a regression to find out which one is the best predictor because I think that's nonsense.

Thank you.

I think which one is the best predictor is going to vary by person.

You just provided a fairly complex picture of how one can think about this and how these different parts are connected to one another. And of course, evaluators oftentimes try to find the small scale that you use to make some claims. What are your thoughts about whether it's possible to develop practical measures of identity that can be used to guide program design or program impact evaluation?

So here I'm going to get on my soapbox. I think switching immediately into constructs like science identity is actually a move backwards. Because I think trying to measure that with a simple measure is probably not the right way to go. I think an evaluator ought to decide what the program is supposed to be producing. If they're trying to get kids interested in science, they should measure interest. If they're trying to raise the kids' self-concepts and confidence

in their ability to succeed, they should measure that. And if they want to measure where they're going to go into a career. For example, if you look at the work, and I'm going to now pick one of my favorite ones that I have trouble with; if you look at mindset, for example, mindset is about convincing kids that they can, in fact, succeed even if it's difficult. I think it's very useful for that. If we've got kids in math classrooms in the third grade and they're already giving up because they think they can't do this, that's bad. And we ought to raise that. Now, does that mean we want to turn them into having a math identity? No. Because for most of them, they don't like it, and they're never going to be a mathematician; they just aren't. I don't think it does any good service at all to say everyone should believe they could be a mathematician. That's not helpful to kids. Kids are trying to figure out what they would like to do, what they would enjoy, and what specific skills they want to take the time to master. We have a core set in schools that we say they must master, and we want to make it as easy as we can for them to master those things. That could be the goal of an intervention.

If our goal is to produce more people that go on and become full-time PhD-level scientists, then we have to do a lot more than convince them. I mean, most of those people are not going to believe they can't get better by studying harder. They're not going to have a fixed mindset because they just don't. They're having good success. They're going along. They're liking, so there would be no reason for them to have a debilitating fixed mindset. And to the extent that they have a fixed mindset, they're on the positive end of it, so that may be helpful that they have a fixed mindset, not detrimental at all. I could even make the case if you're going to go on and get a PhD in microbiology, you'd better have a fixed mindset, and you'd better think you're really good at it. Because otherwise it's not worth your time. So that's why I don't think there's one good measure. It really depends on what the purpose of the program is. I think if you want to get more people to go into something say, for example, engineering—I do a lot of work in this area—what I would do, I mean, this is for gender. I think the main reason, and we've got lots of data to support this, that women aren't going into engineering is because they think engineering is dull, boring, and it won't, in fact, let them meet their goals. So if you want to get them to go into engineering, I don't think you want to change their identity of engineers until you change their image of what engineers are. The first step would be to convince them that engineers do the kinds of things that in their other identities they think are important. Essentially what we want to do is to bring this construct of engineer closer to identities they already have rather than trying to get them to create a whole new identity, that's harder. I would go from the point of “are we having some impact to getting them to think about whatever?” If our goal is to get people in those fields, getting them to think about those fields as being compatible with whatever other identities they have.

I have another soapbox. This is spot-on with what you've just said. I have the other soapbox, which is we also have to change engineering so it actually is the way we're advertising this to the young women.

I think that's happening. If you ask kids I think this is a whole other line, and it's where I've come to after 40 years, is we do a terrible job in our country, and in most countries, giving kids any information about what various occupations do, and STEM is clearly one of those. I mean, what STEM occupation did they know anything about if their mom or dad isn't one? Medical. Because they see doctors on TV and CSI's. Maybe now they have some sense that MacGyver is back. They have this sense of if being embedded in drama, in saving lives or in

protecting the United States or finding criminals. Now, some of them, for some reason, somewhere along the way are exposed to something that get them interested in scientists. They read books about particular scientists, or they have a teacher who can tell them about particular scientists. There was work a while ago about who were the best science teachers to stimulate kids, and they tended to have been people who had been scientists and then went back to teaching. I always thought that was because they could actually tell the kids what it was to be a scientist, and they were a scientist. So the kids got a broad image of what STEM is actually about. I think if we did that, we'd have a lot more people thinking about it. And they might not pick it, but at least they'd be ruling it out for the right reasons, not because they don't know anything. I don't think this is just pertaining to STEM, it's everything.

I agree with that.

You know, so now computer science, because it's linked to gaming, is one that a certain set of kids have a much better picture of at least that aspect of it. They can imagine themselves being a gamer and going from there to be a producer of games. But that's very different from other sciences.

A lot of people, and you mentioned this as well already, the distinction between being clear about what concept we're talking about, and there are other concepts like interest and motivation and attitudes that people are interested in when it comes to outcomes for science. You already mentioned it, but how are they connected to identity? What distinguishes identity from these concepts?

To me, identity has to do with how central these beliefs about the self or these attitudes are to one's own identity. I think that during adolescence, for example, it's all about figuring out who you are. That's where I make a distinction between social identities and personal identities. Social identities are those identities that make you part of a group, make you belong. In order to belong, you have to be what you think those other people want you to be in order to welcome you into their group. That's going to affect behavior through these stereotypes that you have: "I won't be this because they won't like me." "They will reject me." Social identities have strong components about what you should do and what you shouldn't do, and that goes all the way from the way you talk to what career you're in and what your core values are. Personal identities, on the other side, are the things that make you stand out. They're the things that are unique to you, that you're going to put time into and you're going to perfect because that's the way you want to be. It isn't to make other people like you necessarily. You in terms of emotionally liking you as opposed to similar. It's to actually try to be very good at something that you think you would enjoy. And they can—the same identity can fit into either of those categories. I could become a scientist because I want to fit in with scientists, and I like the scientific community, and I want to be part of it. Or I could want to be a scientist because I love doing science, and being a scientist is so much a part of who I am that I can't imagine not doing it all of the time. But that's when I'm in my place of flow is when I'm doing this activity. Now, most people aren't there. I think that's an ideal. Very few people spend most of their life in a state of flow because they're doing what they absolutely love. Luckily you and I and people in academia come closer. We have more of an opportunity to do that, but I would say people that work as an engineer in a company probably don't feel that way very much. People who are working for Dow Chemical probably don't feel that way very much, but they're probably still doing something they enjoy doing.

But it's not because that's their identity; it's what they do for a job. It's what they do for eight hours a day, and it's wonderful, but it's not their identity. Something else is their identity. So I think we need to keep those ideas, and this is in the adult world versus the children's world. I think we need to keep those kinds of ideas distinct and know that you don't have to have this thing be the core of who you are to study it hard, to learn it, to master it, to enjoy it, and to do it for an occupation. Better if you do, but not everybody—that's not going to fit everybody. And it's certainly not going to fill the labor market needs. Most of the labor market needs are going to have to be filled by people for whom this is the best way they can imagine spending 40 hours a week, but it's not who they are.

This is always what I tell friends—that my hobby and my work are the same. If they ask you what else are you doing for fun, I say oh, I'm already doing what I want to do for fun. I'm a very privileged person.

That's right. We are very privileged. So the students ask me that. What do you do with your real life? And I said this is my real life, and there's nothing I'd rather do. So I'm not trying to work/life balance, this is my life. I am so thankful that I happened to land in that position, but there are few of us, I think if you actually look around the world and through history, that's a very privileged place.

With the case that you had before, where you made a very important point about what people should be measuring and what they're measuring and being clear what it is they're aiming at. What are some examples of resources or tools for measuring a descending identity that you have found useful other than yours?

If I wanted to measure [identity], and I would, you need to make it age appropriate. Of course, we don't often. We often take and imagine how we would want to express it, and then we give it to a 10-year old, and that's not going to work. So you need to pilot all of this very carefully with the population you're going to work in. I think if I wanted to get at this core identity, I would use these pictorial measures. I think the implicit identity stuff is probably a reasonable way to go. I don't think you can assume if they can't do it, it doesn't mean that they don't have the identity. It just means that lots of things can affect how fast you push that button. But if they pass that button very fast, then you could probably infer it is part of their identity. On the other side, you can't say well, it's not part of their identity. I think you could also get them to be able to push that button quickly on the yes or no side if you gave them practice working on the computer. You've got to take that into account that there are other things that drive that behavior. I think you could give them some choices between tasks and see which one they pick. It really does depend on what you're going to use the data for. If you want to see whether or not you've increased the extent to which they enjoy something, ask them how much they enjoy it. They'll tell you. A one to seven scale with two or three items works perfectly, and there are many of those around. So you can look at that.

There is [a group at the University of Virginia](#) and at George Mason who are developing a quick and dirty measure of expectancy value on cost measures. They've specifically tried to develop a set of measures that have a minimal number of items. In order to do that, they're having to operate at the general level rather than the specific level. They're going to be getting it at the level of science or math, not at the level of biological sciences versus the

physical sciences. In terms of gender, I think that's a very critical distinction. Because if the girls think you're talking about physics, they're going to appear to be disinterested when they're, in fact, very interested in the biological sciences. So again, that's one of these cases that you need to be thinking about how specific should you be and what is going to be your inference that you're trying to get from it. I actually think we have reasonably good measures to measure these subcomponents, and they don't take a lot of time. You can measure several of them and try to triangulate.

What kinds of measures do you have?

Well, I have measures of ability, self-concepts across a whole variety of areas: math, the various sciences, English, athletics. A lot of skill-based areas, and we have measures of expectations for success, immediate success, future success, and success in occupations or in college. We do how would you do in a career. We have a set of questions that ask them how well they would do in a career that doesn't label the career but mentions the skills. So one that requires you to use math, one that requires you to work with people, one that allows you to work with a computer—one that allows you to program computers. We have items like that. We also have a whole set of items that ask how much you enjoy doing things like that. How much anxiety you experience when you do it, or if you imagine yourself doing it. How comfortable you would be doing these kinds of activities, either in the present or in the future. How important it is to you to be good in each of these things. If you could—how likely you would be to some more of this if, in fact, it was an option. So if you had five minutes, how likely would it be that you would do this kind of thing versus that kind of thing? We find all of these things are very easy to measure on questionnaires. For younger kids, you can use pictorial aids, so they can understand the concepts of a little to a lot by using bars, by using smiley faces. And all of those things are we find pretty easy to measure.

You mentioned that it makes a big difference when you ask a girl—particularly when you don't have time to figure out what is it they're interested in. But you don't want to use the term signs or STEM because it's too broad, they don't understand necessarily or they're making an association you don't know.

Yes, that's the hard part, is you don't know what they're thinking.

Would you then say that potentially it's a useful approach to distinguish and say I'll do this now for biology, and I'll do it for chemistry, or for physics and see the difference between those two, at least for the kids who have experienced these terms already?

That's right. And we do that. These are not hard things for them to fill out. So they can do it quickly, and you don't need ten items. You need two or three items, and you get a very good measure. They make more sense when they're looked at against each other. What we're finding now, for example, is if we want to know who's going to go into sciences, it matters just as much as we know how good they think they are in English. Because if they think they're equally good in math and English, then they're much more likely to pick something outside of science. Not that in science, but then someone who doesn't have that pattern. And that's a girl pattern. So what we're finding is that it looks more like the girls aren't going into science because they can go into something else. Not because they don't want to go into

science. So it isn't science versus not science. It's science versus other concrete things. If you don't ask about those other concrete things, then you don't know why they're saying they're not going into science. And we jump to the conclusion that there must be something wrong with them that they didn't pick science. But there's nothing wrong with them. Most of them have done it because, in fact, for them, they would prefer this to that. They don't have any doubts about that, they could do that fine, but they think they'd rather write novels.

Is there any one publication or good website about that somebody can use as an entry-point into your work that you would recommend?

For that particular point, [Wang and Eccles](#), and there was a psych/science paper. It makes it very clearly, and then we followed that up a little bit. The gender difference is probably thought of as girls having more choices. Girls are more likely to have multiple skills than boys are.

What is STEM Identity? An Interview with Erik Nisbet

On October 18, 2017, [Martin Storksdieck](#), Director of the Center for Research on Lifelong STEM Learning at Oregon State University, interviewed [Erik Nisbet](#) to understand his thinking and work on the topic of STEM identity. Dr. Nisbet is an Associate Professor in the School of Communication at the Ohio State University. Dr. Storksdieck conducted the interview as a member of the Center for Advancement of Informal Science Education (CAISE) task force on evaluation and measurement and is co-Principal Investigator of CAISE.

A video of Dr. Nisbet's interview, as well as interviews of other researchers, is available at InformalScience.org/identity.



Tell us about a project you've done that's focused on identity.

Most of my research is focused on the intersection of science and politics. And in that context I've looked at political identity—people who identify either as liberal or conservative or as Democrat or Republican. One project we did was [published in 2015](#) that looked at the process of motivated reasoning as driven by identity when it comes to controversial science topics. Our goal was to show that motivated reasoning basically serves biased processing of scientific information, possibly the rejection of scientific information, and/or what we call source derogation. Basically being exposed to information and distrusting the source, in this sense scientists, for example, and being politically motivated. Distrust of science is not something unique to those who identify as conservatives or Republicans. The goal of the project was to refute what we thought was a misinterpretation of the science-motivated reasoning by people like Chris Mooney who wrote [The Republican Brain](#) or [The Republican War on Science](#). We felt that literature that approached a knowledge deficit argued that Republicans or conservatives have some type of cognitive deficit when it came to science. We disagree with that and especially in the sense that the science, psychological science, the science of motivated reasoning, the science of political science, political psychology, doesn't argue that at all. It argues that both liberals and conservatives have equally the potential to engage in motivated reasoning around topics or issues that they find somehow threatening or antithetical to their

self-identity, their political identity, their values. That was a study where we selected what we felt were three controversial issues from a conservative viewpoint, things like climate change, or evolution. We then selected three issues from a liberal viewpoint we thought might be controversial like nuclear power, for example. And we picked three what we called nonpolitical issues or nonpoliticized issues like astronomy or geology. I think earthquakes was one of them and Pluto no longer being a planet. So you don't see a lot of political debate in congress about Pluto's status.

At this time contextually, if you look at the overall trust in science, trust in the scientific community, conservatives on a survey compared to liberals report a lower trust. Although I will say that if you actually look at trust in the scientific community compared to other institutions overall across liberals and conservatives, it's very high compared to any other institutions except for the military, I think was the only that scores higher. If you look at all the various institutions: news, politics, social, economic in our country. What we did was expose people to these different messages coming from a scientist that we said was a science learning website, we did it online with a national sample. We found that if you expose conservatives to a short passage about the scientific issue presenting a short factual passage, they read it then they expressed lower trust in the scientific community than the control (which was the nonpolitical science). We found the same thing for liberals as well. If you expose them to factual information about something like nuclear power they're going to express lower trust in the scientific community as well. Our argument is that at this time in our history, this political juncture as we've seen more and more issues become politicized, especially issues that somehow go against or are seen at least framed as antithetical to conservatives or Republicans, often for political reasons, then yes, you will see Republicans and conservatives are going to express maybe a lower trust in the scientific community compared to liberals at this particular point in history. It wasn't the case if you look historically going back 30 or 40 years. We would argue that moving forward, if nuclear power became a major issue like climate change was, in terms of the amount of medical attention and public scrutiny and public discourse and political discourse, you might see a flip flop wherein liberals then become distrustful of the scientific community. It would be really interesting for me if I had the time and the resources to go back and look at the polling. If you look at the antinuclear movement in the 1980s, some of the seminal research I'm framing around science came out of [Gamson's](#) research as a sociologist looking at antinuclear power frames in the 1980s, for example. It would be interesting to look at how did liberals versus conservatives feel about science then in that context. So I think this interaction, when we talk about political identity, I don't think the antiscience is hard coded. It's contextual based upon the science issue being discussed and the amount of both political and media attention given to it. And it might be more cyclical.

So, in other words, the stronger your ideological beliefs in either direction whatever direction it is, the more and more that might trump the factual.

The more likely you are to engage in biased processing of information. If you look at some of the polls by Pew where they looked at where the public stands on certain science issues versus scientists, there are definitely disagreements between scientists and those who hold

more conservative views, but there are definitely disagreements between scientists and those who hold more liberal views.

People also think, and this is another misperception I think among many scientists, that the more educated you are, the less likely you are to rely on what we call heuristics, which are mental shortcuts, and the less likely you are to engage in biased processing. But research by [Kahan](#), has shown that those who sometimes engage in more cognitive reflection and use more deliberative processing information don't actually have less biased outcomes; you might have more. That's why you find often it's not only the more ideologically coherent your political attitudes are, political identity, whether on the left or the right, you're more likely engaged in biased processing. The more politically sophisticated you are, the more likely you are engaged in biased processing. So you often see more of a divide between educated Republicans and educated Democrats than lower educated Republicans and lower educated Democrats on science issues. So I think there are a lot of misperceptions when it comes to science communication as a role that ideology and political identity play in shaping attitudes. Kahan is actually drawing upon the basic science, but there's a great deal of research in political psychology, psychology in general, that underlies Kahan's application.

Having grown up politically in the 1980s in Germany, I can tell you that there was a gigantic bias of the political left against science and technology. It was particularly at the intersection of how basic science becomes intertwined with industrial interest that the left had a huge issue. That's where the Green Party was formed.

You see that also when it comes to GMOs in Europe. Much more there than here. I think some of what you're talking about with Germany is an interesting case where what you see now is a debate of nuclear power. Germany shut down their nuclear power but you actually see that their greenhouse emissions and global warming emissions are actually rising because they have had to rely on fossil fuels because they can't ramp up the renewables quickly enough to take the place of the nuclear power. At least in the short term, they're in an issue with their global warming initiatives. I think that's an issue that if you presented that type of information to those who are liberal, or here in the United States or elsewhere, they would have issues processing that.

How do we define "identity" in your work?

I've looked at political identity. Another area of research I've been developing lately is more environmental identity. I think that is an interesting area of research that's undeveloped because there are different measures of our mental attitudes, our environmental values. You have the environmental paradigm, which people are very critical of. You can take a look at some work in social psychology looking at altruistic, biospheric values, as well as narcissism. You also have research that shows that people who identify as environmentalists are less likely to be politically active. People have said if you want to make political change you actually have to engage in politics. I have done some survey work I haven't published, but actually those who score high on the new environmental paradigm measure are actually less

likely to engage in political behavior. What is that tapping? What does it mean to be an environmentalist? And sometimes people will simply ask explicitly “are you an environmentalist or not?” which is a very reductionist way to look at it. You can also look at research on social psychology when it comes to identity. Identity is actually much more complicated. We have multiple identities at any one time. When I do research on identity, you’re not only going to say you’re Republican, but you are also based upon your gender, class, ethnicity, and your race. When it comes to being an environmentalist, are you an environmentalist or not is somewhat dependent by how central environmentalism is to your identity, your core identity, a sense of self compared to other types of competing identities; socially constructed identities. Genders can be socially constructed, race, ethnicity, politics, as well as the salience. The salience of any one identity changes depending on context. How salient your environmental identity is compared to your gender or racial or political identity depends on the social context. But for me I’m interested in communication. It could be the media context. How does media and communication influence the centrality and salience of certain identities? In political science we often simply define it as are you Republican, Democrat, are you liberal or conservative? When I actually look at the literature on identity, it’s much more complicated.

To what degree do you think identity matters for science communication?

I think it matters greatly across multiple dimensions. I think it matters as we discuss how it influences how we process information about controversial science issues like we already discussed. It influences all types of cognitive process, of selective exposure. What human information we expose ourselves to. If we’re exposed to information, how we comprehend it, do we recall it or not, do we either reject or accept it. So in terms of science communication, science learning is about people being exposed to information and accepting and internalizing information. Then it shapes those processes intrinsically. Another aspect of identity I think is important for us to understand is the role that identities play in shaping motivation and interest. I think especially when it comes to historically marginalized populations when it comes to science, especially gender and minorities. For example, one area of research I’m increasingly interested in is the role of science documentaries from an audience perspective on what cognitive and behavioral impacts science documentaries have. Entertainment film as well. We published something in [Science Communication](#) last year, but moving forward one of the things watching a film like [Hidden Figures](#). The question is what impact does a film like *Hidden Figures* have? For example, there are science documentaries about African American scientists and the history that also promote that perspective, especially on youth or populations that typically don’t see science as relative to their identity as an African American, or as a woman. They might not see science as relevant for a whole host of reasons, as they think that it’s not available to them. It’s not because they’re not only disinterested but historically, institutionally, they might have been because of institutional barriers. African Americans participating in science, they think it’s not relevant to them, for example. A movie like *Hidden Figures* has the opportunity to increase motivation and interest among African Americans. But the question is does it also have an impact on the white majority and their perceptions of African Americans and African Americans’ contribution to science. I think

it's interesting not only in a film like that looking at how it intersects with multiple identities, African American identity, white identity, issues of class, issues of education and background. I think there are multiple intersections there in terms of impacts that I think is interesting. That's why one reason identity is important, and that it goes beyond simply attitudes but it also goes to interest, and motivation, and science as a practice, especially as a way to engage in groups that have socially constructed identities that have been historically marginalized in science. What are the identity components that we need to address on that?

That's fantastic. It's great because we later ask about intersectionality. We also ask later about whether you have to distinguish between identity and concepts like interest and motivation and attitudes, and I think you addressed that just now.

Well, identity drives all those, and it's intertwined with those.

Do you think it makes a difference when you think about science communication now STEM comes in? Does it make a difference when people throw in the term STEM with science for you?

No, but I think it makes a difference when they're talking about educational approaches versus communication approaches. I have a courtesy appointment in the School of Environment Natural Resources, where among some people who deal with science education, communication is a dirty word because they simply see it as persuasion. I say, yes, there are persuasive elements, but it needs to be a persuasive element of education as well. Sometimes you need to persuade people they need to learn. Or persuade people that they don't know what they don't know. So I think education and persuasion aren't necessarily two separate domains. I think some people who say "I work in STEM" versus "I work in science communication" sometimes might view each other negatively. I think [there are] some misconceptions about how the mind works and the role that communication plays in education and the role that education plays in communication. I don't think of a fine and bright line as some people would make it out to be. When it comes to STEM versus science, for me science is more of an overarching term in a sense especially if you bring in health. For me, who deals with some environmental issues, there's a fuzzy line between health and environment. I often view health as a subset of science. Like science, health is an application of a lot of science communication. Health science communication can learn a lot from each other. They are often split differently from each other, but the basics of health communication is communicated about health science. When we talk about STEM, science, and health, I think often we're talking about the same things. Obviously there's a connection between numeracy, for example, and risky decision making, if you talk about the math part of STEM. Does it make a big difference for me, STEM versus science? Not really, though for me, I like science because I just personally view science as an overarching term that includes both STEM, health and risk, and what I consider specific contextual applications that science serves as the foundation underlying all these different specific communicative or educational contexts.

How do you currently measure identity in your work?

Well, sometimes simplistically by simply asking, “do you identify as a Republican or Democrat?” I’ve also been developing two other measures. Other than beyond the standard “are you liberal, conservative?,” “how liberal or conservative are you?” or “are you a Republican or a Democrat?” I draw upon the literature in social psychology in identity. The literature looks at the term called “identity centrality.” As I mentioned, how central is identity to your sense of self? This comes out of a range of literature that looks at racial identity, socially constructed identities. The other area of research I’ve been looking at is environmental values as differentiated from ideology. So looking at altruistic values, biospheric values, and narcissism as when it comes to influencing value orientations. What identities are constellations of values? Identity determines what’s relevant to you, what you value, and what you don’t. The relationship between identity and values is complex. Usually identity is simply for me a package set of value propositions. If you want to unpack something like environmental identity, one thing is looking at environmental values underlying that, in terms of biospheric, altruistic, and sometimes narcissistic. Looking at values and then looking at the social psychology literature on the salience and centrality of identity, and sense of self, are the two ways of measuring identity.

Do you think it’s possible to create tools for measuring identity that practitioners or evaluators could easily use in their work?

I think there is, yes. When it comes to look at the social science literature and identity, there are established scales and survey measures and experimental measures used to measure identity. Whether it’s political identity or racial or social identity or things like science identity. I’ve created and used measures in my work measuring environmental identity based upon the literature in social psychology. The same thing could be dealing around science or other science related identities. I think it’s just applying the social science and tweaking the established social science protocols for measuring identity for practitioners. But there is a readily available instrument to do that where you can use five, six survey measures, for example, that capture the centrality and salience of an identity and that is valid scientifically to use. I mean there is a science of identity to draw upon.

Do you have more examples of resources or tools for measuring understanding identity that you mentioned?

I would say there are established scales in psychology going back 30 or 40 years that have been used to measure identity across a range of contexts. It’s very easy to find those. Work by [Crocker](#), [Marcus](#), for example, and journals like [Personality and Social Psychology Bulletin](#), [Journal of Personality and Social Psychology](#). There are top basic site journals that are used across many different studies looking at racial identity, ethnic identity, other types of socially constructed identities. Marcus is a political scientist who has done work on identity, group identity, and political cohesion. I think it would be very easy to create a primer on the social science of identity for practitioners based upon some of these established scales. If you’re going to do an evaluation, for example, and you want to measure the audience’s

environmental identity or their identity as a scientist, or political or racial identity, there are established measures of that I think could be easily employed on some type of questionnaire. I would just encourage your group to take a look at that and maybe make some of those scales and research available for your practitioners.

Is there anything else about identity and science learning that you would like to share?

I think that scientists and science communicators and practitioners who work on projects and informal science learning have to think about how their own identities influence their perceptions around science and that of the audience. You need to be self-aware that being a scientist is an identity. Just as we talked about identity is shaping how audiences process information, especially in a biased manner, that our own identities as scientists or science educators, or practitioners, heavily process whether we want to admit it or not, our own understanding of audiences, how we communicate, and what we communicate or teach. We often don't take that into account, and I think the science communicators and scientists and the science communication and science learning communities don't take that into account as well enough. That creates communication gaps, and one of the major challenges in science and science education is not the audience but ourselves in taking into account our own biases driven by our own identities.

What is STEM Identity? An Interview with Heidi Ballard

On October 31, 2017, [Jamie Bell](#), Project Director and Principal Investigator of the Center for Advancement of Informal Science Education (CAISE), interviewed [Heidi Ballard](#) to understand her thinking and work on the topic of STEM identity. Dr. Ballard is a Professor of Environmental Science Education at the University of California, Davis. Dr. Bell conducted the interview on behalf of the CAISE task force on evaluation and measurement.

A video of Dr. Ballard's interview, as well as interviews of other researchers, is available at InformalScience.org/identity.



What projects have you done that focus on identity?

Well, so that's a good start because it gives me something concrete to talk about. It's of a core area of my work, so I have lots of projects that I could give you an overview of briefly and then maybe you tell me which ones sound like you'd like more detail. I would say the first project where I really started to dig into the idea of identity, particularly with respect to science, and probably spawned a lot by that National Academies report, is for a project that I am doing with the [Cornell Lab of Ornithology](#) folks on what we call [EESIP, for Examining Engagement and Science Identity Through Participation](#).

And so what all of my projects are looking at is how and what people learn and how they participate in citizen science projects or other kinds of community science projects. So in the EESIP projects we were specifically looking at what I later learned were "narrative identities." We just did phone interviews with 80 people across six different citizen science projects that we structured as stratified by the levels of the models of citizen science that we talk about as collaborative, contributory, collaborative and co-created projects with increasing engagement into the scientific process from those three.

And then we selected folks that were engaged variously in those projects and interviewed them over the course of four years, and we've just done our last round of interviews. We asked those folks not only real details about how they participate in the project, what exactly they do when they consider themselves to be participating in the project but also how they

see themselves with respect to science. If they see themselves as knowing, as understanding and doing science, if they think others see them that way, those kinds of questions. Another more recent project is what we call the Youth-Focused Community and Citizen Science and that one is focusing on youth as participants.

The previous project was adults exclusively, and so the youth-focused project is actually digging in a lot more with the idea of agency. We're looking at case studies of about 10 different cases, trying to represent the range of ways that kids participate in citizen science and community science projects, and we did interviews and field observations any time they were doing anything with the project. We did pre- and post-interviews, and we were looking at a lot more of the sort of enacting of identity and how the kids are moving through those spaces, how they're seeing themselves, the roles they take up when they're participating, and the expertise that they see themselves gaining in particular science and environmental science areas.

So that's the project where we looked at the fact that because in citizen science and community science so many claims are made about people taking environmental action as a result of doing it, enacting, engaging with their community, civic engagement, i.e., making change in their community as a part of community science. We wanted to look at that, so we started looking at agency and how people, i.e., kids, saw these science activities that they were doing, and participating in science as also acting on their world.

We came up with this framework of environmental science agency where it's looking at how and what kids come to understand about the norms of knowledge, skills, and inquiry and processes of science. But also what roles they take on and how they identify their own expertise—that's the identity piece in those areas and in what ways do they use them—that is to say, science, to take action either in the environment or community.

We took that framing, and we're still analyzing a mountain of data, but we have identified key practices that kids seem to be going through when they were developing environmental science agency, and when they were taking on and seeing the ways that they could use science and the science they were learning in the project to take action in their lives. And we looked at those things that kids were going through, things like key practices and youth having ownership over data quality, when they were allowed to. They were seeing themselves as experts in some small method, some particular part of the science process that was theirs and they started taking it to other parts of their lives, taking it into school, taking it into the after-school program, things like that.

We saw that as a key practice. We have others, too, and we're trying to identify more with all the data, more cases that we have. Then we took this framework and used it with a third, new project that I've got going. We're in our first year, and this is one of the [Science Learning+](#) projects funded by the U.S. National Science Foundation, with the Wellcome Trust and the Economic and Social Research Council (ESRC) in the UK, and it's a collaboration across researchers and practitioners and natural history museums.

The three natural history museums that we're partnered with are the Natural History Museum in London, the California Academy of Sciences in San Francisco, and the Natural History Museum of Los Angeles County. And those folks who are running citizen science and community science projects out of the museums, or led by the museums that are working on

the science in those museums, the research that those curators and researchers are working on and engaging in citizen science. And again, we are looking at youth. So we're taking up this environmental science agency framing to think about identity and applying it to these very different settings that include the online settings like [Zooniverse](#) and [iNaturalist](#) as well as short-term settings like the bio blitzes, where it's a one-day event. So if you think about identity development, for example the question of whether someone's identity with science is going to be impacted by a four-hour event in a park somewhere, that's the kind of thing we're trying to look at.

I am also using the environmental agency framework with a new project with Public Lab looking at community science, which is focused a lot on environmental justice issues like water and air quality monitoring. And we're also applying the framing to adults because it's going to look really different with adults. So with that one we're doing some small case studies with groups that are tackling an environmental problem or question in their area, one in the Gulf region and then one with frac sands in Wisconsin.

Across all those projects, do you think about a definition of identity? Is it contextual in each project or, as you said when enacting identities, there's a way of thinking about it that might be different than other projects?

There's a couple of ways that they are different and a couple of ways that they're really similar. My perspective on identity and identity theory and the research that gets done and the different ways that identity gets studied has evolved in the last seven years or something when I started working on the first project.

The EESIP project looking at adults is the way into a kind of definition. It's looking at how people tell stories about how they see themselves, and so it's just the narratives that people tell in reflection on their participation in the projects. And so it turns out that that's only one way to look at identity. We're really [working with] usually very articulate adults. It's hard to have a five-year-old really be very meta or talking about their identity, right? But with adults, you can ask a lot more sort of meta kind of questions about how they see themselves.

So thinking about those narrative identities, it gives you a picture of the universal things across all the projects is identity, is about how people see themselves, how they feel like others see them, and what kind of a person they want to become. And I think across all the projects, it's very consistent that identities are not fixed. They're not fixed in time. They're not fixed in setting, and so you can be a different kind of person and see yourself in a different way as a different kind of person with respect to science or with respect to anything—lots of different ways over a given day with different people. So the whole idea of identity as situated, learning and identity are intertwined through what you do and who you interact with. That's true across all of the projects.

I would say that the first project, the adult-focused project is really about the stories people tell about themselves. Whereas, with the kids, what's also very cool is that I've learned a lot about identity research and that being able to observe people while they're doing the practice because identity is about practice. A lot of learning theory talks about how people form their identities through practice, and those things are shaped entirely by a setting and the people, but it's about that practice. So it's about being able to watch kids or people

participate in the projects doing the thing that they are focused on, who they talk to, and how they talk and position themselves.

We talk a lot about roles and positioning, so watching the interaction really matters. That's where those projects are really different, in that we're doing a lot of really focused observations on the youth-focused projects because that's how we've been able to structure it. But in terms of the definitions of identity across the board, it's situated. It's interactional, and being able to really watch those interactions makes a difference.

And you already said this, but is identity, in as it manifests in those different projects—do you see it as integral to the learning?

Oh, yeah. There's lots and lots of research out there already on the knowledge that people take up, i.e., the science knowledge. And there's a lot that's getting better about looking at inquiry and how people are thinking and reasoning around science. But, what that [Learning Science in Informal Environments](#) book really did is highlight that identity is a specific aspect of learning that seems to really influence a lot of the other things. I see identity as influencing all those other areas of learning, and so if someone identifies with science and sees themselves as someone who does science or understands science or uses science, then that's going to influence what they decide to study in college or what they decide to take for a job or what they decide to do when they're choosing a car to buy. All those sorts of things get influenced by how people see themselves with respect to science.

In your conceptions of it, and as you're working with this construct and measuring it in the projects that you mentioned, are there ways in which your thinking about it and/or measuring it that you would say are distinct from what you know others are doing?

Yeah. It's interesting because I'm trying to be in conversation with a lot of different people. So when I do this work I'm learning so much from the research and theory that's going on right now. But I know that there's a lot of research out there that thinks of identity as a lot more static and takes on a kind, a particular identity, and talks about types of identity. They assign people to these categories, and if you see yourself as a "birder," that's how you see yourself, and that's your identity. And so now I'm going to approach [as a researcher] anything that I think about you because you see yourself as a birder. But it may be that I only see myself as a birder when I'm outside, and I don't see myself that way 90-other percent of the time.

So in that way, I think that's different. Also by assigning people to boxes and saying identities are static—there's lots of research that is survey-based and basically asks if you see yourself as a scientist or not. So that's something that I will completely unpack and say needs to be changed in all of my projects, which is that it is simply not the only way that you can think about yourself with respect to science.

So all of these surveys that just ask, "do you see yourself as a scientist?" are missing a lot of the story. In the EESIP project we identified eight or so really solid, different aspects of science identity that are not just whether participants see themselves as a scientist.

When we're talking to adults on that project, and also on the community science project, one of the main findings is that people specifically say they do not think of themselves as scientists, and they don't want to. It's like that's someone else's job, and that's great. There are scientists that are working on this project, but I am someone who is collecting data or doing advocacy and outreach for this project. Or, I am a teacher working with other people to help them participate in this project—so people have lots of other ways that they identify with science and identify with the project that aren't just about being a scientist.

I think that's a huge difference. The other thing with the youth projects is that we're trying to get away from—and I was a high school and middle school science teacher for several years, so I know about multiple choice tests and standards and that there are some things we want kids to learn by the time they get out of school about science—but with these informal settings, we're really trying to see what aspects of science do kids take up that they see as meaningful and consequential for their own lives.

And that's important because maybe a kid realizes that talking to strangers when they pass by as we're collecting water quality data is part of science. So I don't think of myself as a math person, but I'm a chatty person so maybe I can still do science, and that's a really important piece that's different from maybe some other ways that people think about identity. It's also consistent with a lot of other folks that I'm learning from who think about identity as a process, and a gerund, and that it's iterative and generative and all those kinds of things, so I love that idea of it as a gerund.

Obviously you're thinking about it, as you said at the beginning, and its nuanced and complex, and so those things need to be attended to in the different contexts that you're studying it. You've already mentioned a few ways—a few methodologies for measuring the construct. So could you just say a little bit more about those? What are the ways in which you're measuring identity?

So, again with the adults, we're relying really heavily on the interviews. And the main thing that we try to do is ask really open-ended questions first and then zero in if we don't hear specific details about things that we're interested in. But the tack we took on these longitudinal interviews was to be really explicit and bring the interviewee into our thinking, and not be “cloak and dagger” about it, like asking them questions where we're then going to judge whether they've changed their identity with respect to science over time, or where we ask, “do you think that participating in this project has changed the way you think about science?” If you ask how you see yourself with respect to science. Tell me about that. Some will respond “no, not at all. I do not see that.” But then if you probe a little bit more, some stuff other comes out, so we try to get at it both ways.

Longitudinal interviews over time, where we keep some of the questions the same and some of them we modify or add over the years. The field observations, primarily ethnographic field observations, for the youth projects and trying to really pay attention to the “focal youth.” It's really pragmatic to look at the focal youth that are in a group. So, you might have one or two focal youth in the group at a time, but seeing how they position themselves when they're taking on something or asking a question or making a move versus when they're hanging back and making notes about those kinds of things in the observations, how they interact with the

adults and what the adults do or don't, what the adults open up or make space for and what they squelch.

And we're doing all this really rich observations and then these pre- and post-interviews with kids, and that's giving us these great rich stories about, and examples of, what it looks like when someone's doing this kind and how their identity might be changing, or ways that they're tackling new aspects of their thinking and identity. But the thing that we've been getting from practitioners in the field in citizen science, from people working with kids and people working with adults, is that it's nice for us as researchers to be able to do all that in-depth work, but what about us? How are we supposed to look at identity and agency in our participants when "I'm just a project leader for a citizen science project?" or "I'm just a teacher." [They say] "I don't have time to do that kind of stuff." So in the [Science Learning+ project](#), we're calling it "learn citizen science," and we're planning to develop surveys, and we're going to try to translate what we've been learning about capturing aspects of environmental science identity into survey questions. It might still be that you have to make a lot of these questions open-ended, e.g., it's probably not going to be a drop down menus and multiple choice. But it's still not going to be replacing the more qualitative, ethnographic stuff. But we are working on surveys and survey questions because that's what's realistic for practitioners.

How do you think about how other identities besides science identity, e.g., gender, socioeconomic status, ethnicity, etc. How do those, or what influence do they have on science identity, and do you take that into consideration?

Something that I should make sure to point out is that I think what's really cool and important about looking at identity, when you're talking about science learning, is that it's about prioritizing how people from really different backgrounds and people with lots of different experiences in their families and in their neighborhoods with respect to science actually can be resources for taking up science in terms of how you identify with science.

So the idea of looking at identity and agency is—going back to my roots and participatory action research where you have to think about power, and the fact is in a lot of contexts, science is power—whether someone identifies with science matters in how much control they might feel like they have in their lives. And so certainly with respect to environmental issues, land management issues, and things like that, science has a lot of primacy.

If you're thinking about communities of color, or low-income communities, if you're thinking about young people, those are all communities that don't necessarily identify with science in the ways that provide a lot of control and power in decision making. So that's how we think about what we really are trying to pay attention to, and specifically not just talking about citizen science, which is basically a white, middle-aged, well-educated thing to do in a lot of this country, but to also talk about community science. And we're looking at those contexts where people that don't necessarily have a lot of say, in pollution, e.g., pollution campaigns where they can take up science and use it for themselves in ways that give them more power.

In terms of thinking about the identity, we listen for when people talk about how their other aspects of their identity, age and gender and race and ethnicity and sexual orientation play into what they're doing with respect to science. But we haven't been asking those questions explicitly ourselves.

There's a lot of talk about intersectionality and the other constructs that are maybe related like interest, motivation, self-efficacy. You've clearly thought about those as well and how they intersect. Could you say just a little bit about that? And in looking at identity, how do those reinforce or play against it?

Well, so that actually was a big, hairy mess for us in a lot of ways. I still struggle, and I would go to the literature and see some of the explanations about interests or motivations that were nearly identical to some of the explanations about identity that I was seeing and seeing how those pieces fit together. I'm still trying to make sense of that. I tried really hard to think about whether identity was an umbrella under which interest and self-efficacy fell or that maybe it's more of a Venn diagram where there are, you know, overlapping sets but not entirely. So we, I, struggle with that a lot.

I think that interest has a lot of overlap with identity, but it's not the same. So I guess I would say that I do kind of see identity as more of an umbrella. And I know also that theoretically self-efficacy as a construct comes from a pretty different place from a lot of the identity research. We ask questions in the interviews on it about confidence, like how confident are you in your ability to [do this]? And that's when we say we're looking at self-efficacy. I know that one of the researchers I've looked at, who does think of identity as whether someone sees themselves as a scientist or not, did an entire study with self-efficacy questions and identity questions and how those things relate to each other—distinguishes between them. And I would agree that those are kind of overlapping sets.

Does your self-efficacy thinking, does that come from the Developing, Validating, and Implementing Situated Evaluation Instruments (DEVISE) project at all? And, in general, are you in alignment with DEVISE?

Yeah, so the [EESIP](#) project that I've been talking about, the portion of that project is those interviews is focused on science identity, but the other piece of that project is to give the [DEVISE](#) surveys to the participants in those same citizens science projects. And that's what Tina Phillips has been doing, and what we're doing now is really the fun part, where we are looking statistically at the way different projects or different kinds of people answered the DEVISE survey questions with respect to self-efficacy, with respect to science inquiry and science inquiry skills, which were really just questions about their confidence in those skills. So it's a lot more self-efficacy stuff and a survey about their motivation—how does that jibe with what we're hearing in the interviews.

And so what I've been focusing on, which I think is just so fun, is to say, “okay, how did this person that I interviewed for four years answer the survey questions [over time] and does this make sense or does it sound like two totally different people?” Initially they're pretty consistent with each other so, happy day, they're, corroborating each other. But then, how did the interviews flesh out what we heard in the DEVISE questions, and what's the flesh that we can put on the bones from the survey? The survey was just a snapshot in time, whereas the interviews were over four years. So we can say we gave this person a survey in year three of four, so how can we see where they came from and where they went? It's really cool.

Any resources you would point people to?

You brought up DEVISE. So if you're thinking broadly about measuring and understanding, and informal science learning outcomes from citizen science participation in particular, then [look at] [the evaluation handbook for citizen science](#) that is on the [Citizen Science Association website](#) that came out of Cornell Lab of Ornithology and includes DEVISE. But the authors are very clear that they do not try to tackle identity because it's a big, hairy construct. And so that's why we did this project. This was a follow up for them on DEVISE, where we try to dig into science identity with these other methods that that I'm using.

But so for identity, in particular, the couple of things I would actually like to point you guys to from our work are resources for practitioners about environmental science agencies. So we have research briefs that are [two-page, color glossy PDFs](#) about what environmental science agency is and about what agency is and why it matters, and what are five journal articles I could look at if I were a practitioner and I wanted to really dig into this and cite it for a proposal, for example.

So those research briefs are on the website, the [Youth-Focused Community Citizen Science \(YCCS\) site](#) at UC Davis. But then also we have [research briefs on the key practices](#) that we've figured out really matter for youth. So if you're thinking about designing or implementing any citizen science project, or any kind of science inquiry with kids, these are some practices; and on youth, sharing findings with outside audiences, their data ownership, (taking ownership of data) and then their engagement with complex socioecological systems, like seeing the social and ecological systems as intertwined.

Those are the key practices that we've done research briefs on so far. But one of the things that we'd like to do for the [Science Learning + project](#) is to get some of these tools out. Eventually we'd like to have these surveys out for people to use, but that's going to be a few years probably.

The other thing is that we have videos that that I'm really excited about because [one has all our project partners](#)—so museums, educators and schoolteachers, and then researchers and environmental education organization people all talking about why youth-focused citizen science might be good for learning. Why we are seeing it as good for learning, science learning. And [the other one](#) is talking specifically about environmental science agency and these key practices.

What is STEM Identity? An Interview with Lynn Dierking and Dale McCreedy

On November 20, 2017, [Kelly Riedinger](#), Senior Researcher at Oregon State University's Center for Research on Lifelong STEM Learning, interviewed [Lynn Dierking](#) and [Dale McCreedy](#) to understand their thinking and work on the topic of STEM identity. Dr. Dierking is a Professor in Oregon State University's College of Education, and Dr. McCreedy is the Vice President of Audience and Community Engagement at the Discovery Center at Murfree Spring in Murfreesboro, Tennessee. Dr. Riedinger conducted the interview as a member of the Center for Advancement of Informal Science Education (CAISE) task force on evaluation and measurement.

A video of Drs. Dierking and McCreedy's interview, as well as those of other researchers, is available at [InformalScience.org/identity](https://informalscience.org/identity).



Tell us about your work related to identity.

McCreedy: So, several projects come to mind. Certainly, the one that you identified Lynn and me as partners on is our [Cascading Influences](#). Also, I'm part of a number of advisory boards, and we are project participants in several. One is [SciGirls Seven](#) through Twin Cities Public Television. Lynn, I believe is also on. I'm on several of their advisory boards, but the one that's most focused on identity I think is the one that both Lynn and I are on together. I'm also involved in FHI 360's [Furthering Girls' Math Identity](#) Project and am a co-PI on K2 Communications' [giant screen film](#) coming out on the Hadron Collider, and there is a piece of that research (there's been a little delay in getting funding, but it's now moving forward), I'll be working on a research study with Valerie Knight Williams on the identity development of women in physics and the ways in which this film can engage girls and women in an effective way. That will be upcoming and has not started yet.

Dierking: I worked with Dale on [Cascading Influences](#), and you commented, Kelly, that it was an important study for the field. It was really important for me. I think it really got me beginning to think about identity, and that's become an area that I'm really trying to focus on. I'm working on a long-term relationship. It's a research practitioner partnership in

Portland Community called [Parkrose Synergies—Understanding and Connecting STEM Learning in the Community](#). And, we've been tracking youth from fifth grade through ninth grade, and there's an identity piece related to that. And, trying to understand how they, or if they, continue to participate in STEM. And, also, trying to understand their interest related to STEM. Identity becomes a really important part of that. I worked with Scott Patterson and an entire team of people at the Oregon Museum of Science and Industry (OMSI).

I worked at MSI on a project called [Designing Our World](#). The focus on that project is trying to use a program and pretty close work observing girls interacting and trying to see how they develop identities, if they develop identities around engineering and design. That's been a really fascinating project.

I'm just beginning a project that is one of the Science Learning+ partnership efforts, and I'm working with Angie Calabrese Barton ([Partnering for Equitable STEM Pathways for Underrepresented Youth](#)) and she's leading a team in East Lansing, MI. I'm leading a team here in Portland. We're working with Louise Archer and Emily Dawson in the UK, because these projects require collaboration between the two countries. We're actually getting deeper into youth researcher work. We did a little bit about synergies, but we're actually beginning the project by having youth develop biographies about themselves, and identity is a big part of that. As I said, we're just beginning, but I think it's going to be an interesting way to try to delve a little closer. What's great, and I know Dale will relate to this, is by having the youth share their experience with us, we're trying to ground it in their own words, in their own sense of self, and deal with issues around their ability to be empowered. And, that was something that we tried to do in Cascading Influences, as well, by figuring out how girls talked about science and STEM and how they talk about themselves and trying to connect those two.

Across those projects, how do you define identity?

Dierking: I try to really think about what the root of identity is, which is about identifying and connecting with a topic and feeling like it's a part of your life. That, I think for me, is one of the things that we did in Cascading Influences—we used personal meaning mapping, and we actually gave girls, young women, a map that said “me,” and had them write things down, and interviewed them a little bit about that. And then, we gave them a map that, instead of saying STEM, was a program that they had participated in. We started with science. It wasn't as useful, but when we put the program on the other sheet of paper, they were able to write and talk about what they did. And then, we put them side-by-side. And so, that's sort of a long-winded way of saying do youth perceive, and people perceive that science is a part of them.

Would you mind explaining what a personal meaning map is?

Dierking: It's a type of concept mapping that John Falk and a group of researchers at the Institute for Learning Innovation developed to try to see what people knew about a topic. And, actually, it's been a useful tool that a lot of people have used. We used it in a different way that it had ever been used. That was, by the way, the point in the project where we were able to see how girls talked about themselves, and also how they talked about science, so that then when we developed this questionnaire, web-based survey we could actually integrate their words and their ideas into it.

Dale, how do you define identity?

McCreedy: So, there's a couple of ways that I've really thought about identity over time, and my first work that actually preceded the Cascading Influences was thinking about the identity, development, and transformation of adult women who had been participating in a program, in a couple of the programs, actually, that ended up leading into the Cascading Influences project. I was looking at transformation of adult women who had participated in training workshops, and working with girls, and in the Girl Scout organization with a science project we were running, and, thinking about the ways in which they did in fact change their own sense of who they were. So, in many ways, I think of identity as sort of someone having a sense of who they are, what they can achieve, what's possible. And, as something that can evolve and transform over time with certain influences.

For example, [this is true] for even a facilitator or a teacher. In [one] case, women whose identity was not one of someone who could facilitate science, but, by the end of being involved in training and working with girls, that sense of self changed.

The same with a woman who was a scientist. Her sense of being a scientist was challenged in some ways by the environment in which she worked professionally but enhanced by the ways in which she was engaged and could exert agency in the work that she did with Girl Scouts. So, I think there's a great overlap with how one plays out who they are and their sense of identity—and the literature based on possible selves, is really tied into that as well.

Would you mind elaborating on what possible selves means?

McCreedy: Yes. It's really about thinking. So, if one thinks about the ways in which many of us who try to encourage girls and women, or youth, to do science, it's about thinking about what's possible. Can you see yourself as someone who could be a scientist? Can you see yourself as someone who can be an artist? Can you see yourself as someone who can be whatever it is? It's really part of being able to imagine yourself and begin to work towards something.

It's about seeing it as an opportunity, seeing it as an option for you. I think in many of the programs and efforts that happen in informal settings, part of it really is about that engagement and seeing that you can have an identity of someone who does science. I was involved in the National Research Council Report [People, Places and Pursuits](#). One of the things that we did was in thinking about the strands of science learning, we built on those that were developed for school, and bookended those strands; one with engagement, and the other one with identity development. The idea that one can actually begin to see themselves as someone who could engage in, in our case, STEM, STEM learning.

Why, and in what ways do you think identity matters for science learning?

McCreedy: Just to continue where I was, I've been thinking a lot more about what it means to be exposed to informal opportunities, because I'm working in a much more rural than urban area, now that I've moved to Tennessee. Although where I'm based is not so rural, the communities that we're trying to connect with and support are much more rural. As I think about that, again, children and youth can imagine things that they've seen and known. And, so, I think it's hard for one to imagine being something that they don't even know anything about.

I think that it's really important to have a sense of what's possible as a way of being able to expand the potential. For many years I've been an advocate and developer of programs that were about girls and women in science. I've never felt that I was trying to turn every girl or woman into a scientist, but I've always felt that they needed to see what was possible so that they could make choices, and they could actually have an opportunity to think about what would be a good fit for them.

Dierking: I would just reinforce what Dale's saying that going back to the way I think about identity is identifying with, connecting to, and understanding the scientific enterprise and how youth fit into it. It seems to me it's a critical piece of engaging someone in thinking about science, thinking—paying attention to science communication and so forth. The community we're working with in Portland is a low-income community. There are over fifty languages taught. It's a fairly small district community that we chose. It's not a school-focused project, but we did use the boundaries of the school district; it's very, very diverse.

When we do our IRB, we actually translate our parent consent form into four languages beyond English, and we're not, of course, covering all of them. We do Spanish. We do Mandarin Chinese, Vietnamese and, interestingly, Russian. And, it's just fascinating, because when you talk with youth, we have a group of youth who have stayed very interested in, and we're looking at STEM across this long period of time, for four or five years. But, when you actually ask them if they see themselves doing something in STEM later, even the youth who have remained interested and participating in STEM, they say no.

I think that's a huge issue, and we have to figure that out. And like, Dale, I agree. Dale and I used to laugh. We don't want everyone to be a STEM person. It's not that all STEM people are dull, but we want the artists, and we want humanities and all the other kinds of people in society. But, we do want youth to feel like they could do science. A big issue of mine is to do science even as a leisure pursuit, or as a hobby later in their life. So, they do attend to science communication. They listen to Science Friday. They engage in ways that they have a science rich life, whether they pursued a career or not. So, I just think it's critically important.

There's a lot of ways that people approach and think about identity. How is your approach distinct from other approaches?

Dierking: One of the things that I've been trying to do in recent work that I'm the lead on—we didn't do this with Designing our World, but certainly with Synergies and now with our Science Learning+ Project, [Partnering for Equitable STEM Pathways for Underrepresented Youth](#). We ended up trying to find a [program] name and used youth to figure out what the name should be. The name is [YESTEM](#), with one S. We had youth both in the UK and in the US. We gave them some choices, and that was the one they selected.

But, what's really important in that work is looking at it over time, which I think is critically important. The other piece that we're really seeing in the work is, and this was, actually, something that Scott Patterson and the team working in Designing our World [noted], that identity could be very situated. And so, someone may identify with STEM when they're doing an engineering activity, or if they're school-aged, doing some kind of lab. It's not clear that that identity goes with them across settings, or across time. Trying to figure out how we can understand how that might happen, and give youth (in the case of much of my work it's

youth) the tools that enable them to continue to connect and build this identity, if it's something that isn't really meaningful to them.

You talked about situated identity. And, one other thing you mentioned was it was critically important to look at identity over time. Is that why, because it can be situated, or can you talk a little bit more about why it's so important to study over time.

Dierking: That's a great question, Kelly. For two reasons, one is yes, we want to understand over time and over settings how identity connects and how it may be situated or not. But, the other piece that's really important is what we've done in synergies. We started with fifth-grade age youth, they were around 10, and followed them through [age] 14. What we wanted to see across time was how they build and develop an identity. I think Dale mentioned that too. This notion of building identity, and what the factors are. What are the critical moments that really make a difference for youth to be able to connect and identify with STEM?

Dale, is there anything you want to add about how your approach, in terms of approaching identity, is different from others?

McCreedy: For me, the difference is more about audience. Historically, my focus has been on adults as critical intermediaries to youth. Although I work with youth some, in a variety of ways, the biggest focus of my work, over the 28-29 years at the Franklin Institute and now here at Discovery Center, has been really thinking about the ways to engage adults in the community—librarians, teachers, parents, youth group facilitators—all of those people in thinking about themselves as actually having influence and having power and the potential to be critical influencers of youth. And, I think in order to be able to play that kind of role, one has to think about identity, and what role that plays. One has to think about issues of confidence, competency, capacity, and comfort. In building an identity—with all of these people—I think my focus has always been on trying to make sure that these critical adults feel both comfortable and understand that everybody can't know everything, and that it's okay to say I don't know, and that there can be the potential for collaborative learning across generations. That's certainly not novel. A lot of people, potentially, engage in those things. And certainly, Lynn has already talked about some of the ways in which those have been aspects of the projects. But, I think that recognizing the fact that so many different adults can have a huge influence is important, and to think about the ways in which their identity is part of that is critical.

You talked a lot about the adults as intermediaries. In your research are you primarily collecting data with the adults, or are you collecting from both?

McCreedy: First of all, let me step back and say that I am more practitioner than researcher. And, so, I play small roles in those sorts of pieces. I'll play a small role in some upcoming research we'll be doing with Head Start teachers and thinking about capacity and comfort level with that. I think that, for me, my focus has been more on getting feedback from them, getting a sense of confidence from them. We've had a number of projects now, [Parent Partners in School Science](#). I work closely with Jessica Luke on thinking about parent engagement, and thinking about parents have identities as someone who can, actually, make a difference not only their child's learning but in their child's school. Seeing how that plays

out at the child level has been really hard because I think there are so many influences in children's lives. What Lynn's been able to do with the Synergies is—I'm sure she'll have some great examples of how hard that is, and how intense that is. So my focus has really not mostly been on the kids but on the adults.

Is there a difference between a science learner identity and a STEM learning identity?

McCreedy: Well, I'll just jump in quickly and say I know I've had this discussion too, even with some NSF program officers. STEM is a great acronym, but it's four different things with overlap—science, technology, engineering, and math. I think that they're distinct but overlapping. I do think that math can be considered a gatekeeper for so much of science, Lynn and I both saw this in our convening for the Cascading Influences report. We pulled together both adult researchers, as well as adults who were the girls in our project, and in our study. Many of them voiced huge concern about math, and saw math as a gatekeeper. There was a very intense discussion about the role of math and how integral and requisite it really was for pursuing STEM. Although, I would actually argue that yes—physics and engineering all very much need math—on the other hand, many of us are required to learn things on the job. I do think that there are some areas of science that shouldn't be shut down because of the lack of confidence or maybe inadequate capabilities in certain areas of math. So, I like to think of them as a little bit more distinct. But, again, engineering is applied science, right? You can't separate them. Technology is part of all of that. So, I don't know if that's really answering your question.

I think if I could summarize what I think you're saying is that they are all interrelated, but that they're separate in a sense too. They're like how I identify in science might be slightly different than how I identify in math, even though there are connections.

McCreedy: Yes, I think identity development could be different with those, and I also think each of those may provide different levels of access or barriers to access.

Dierking: Again, I want to reinforce what Dale's saying that it really is an acronym, and it's something that we learned in Synergies. As we were trying to understand their pathways, we didn't want to say to the youth, "Do you participate in science? Do you participate in technology?" We developed a whole set of items about, "Do you like to take things apart? Are you curious about how something works? Do you like to do puzzles?" Just a whole range of things. What's so fascinating is that we were trying to think of the different areas. But, what came out very strongly was that youth identified with different parts of that notion of STEM.

Early on in the fifth and sixth grade, boys tended to identify more with technology. Interestingly, that has changed over time. Girls, in particular, in the early middle school years were very interested in life science, specifically the human body, and we can understand why that might be the case. Something that, I think, is great evidence that these are not clumped together is that when we tracked these youth for four or five years, we could see that typical decline in interest and participation between fifth grade and eighth grade. But, what was really curious, based on a very kid friendly "tell us about yourself" instrument questionnaire that we gave the children once a year in this community. We also were tracking, initially, twenty youth. It became fifteen (why you over sample), and we were conducting interviews

with these youth every four to six, eight weeks, in their homes. And, what was really curious is we saw a subset of youth in those case studies that were still passionate about what they had been interested in at the beginning, or maybe the topic had changed, but they were still passionate about some element of STEM.

So, a very, very knowledge person on our team, Dr. Nancy Staus, decided to do a secondary analysis. What she discovered is that that decline was not uniform across all youth. And, in fact, there were three groups of youth that emerged. There was a group of youth who had maintained their interest across all science, technology, and engineering and math across the whole time. In some cases it went up a bit. There was a group of youth, sadly, who had lost interest in all of the dimensions. And, there was a group of youth (and this relates to what Dale was saying a few moments ago) for whom their interest in science, technology, and engineering remained the theme in their participation, but their interest and connection to math very precipitously declined. And, more than half of that group was girls. And so, I think those data—the piece of evidence that if we say—if we talk about STEM, we’re not just talking about this single thing called STEM. We’re talking about these different aspects of science, technology, engineering, and math.

What’s exciting is we now are working on an NSF research in service to practice grant to try to use those categories, and figure out are there things we can do to help girls maintain science, technology, and engineering, and have a more positive connection with math.

I told you about the youth who still are interested in STEM but don’t see themselves doing it. What experiences could we provide them that might change that pattern? And then, of course, the youth who have totally dropped out of thinking about science, technology, engineering, and math. Are there things we can do to encourage them to reconnect? Because, that’s one of the things I would say about the benefits of the long-term view of identity is you see youth getting excited about something, and then losing interest, sometimes sadly because they don’t know what to do for the next step to continue being interested in it. But, you can see that this is not as monolithic as I said, or uniform as one might think it would be.

So, you’re looking at the nuances and using the findings to think about different ways?

McCreedy: I think this really ties to findings that Lynn and I had in our study, and that other people have raised both before and after us, which is what counts as science. In our study, the women who responded to surveys, when asked if they were involved in STEM-related careers of any sort, only 17% said yes. But when we actually coded by their careers that they listed on their surveys, it was something like 48% were actually in STEM-related careers. And that is further confirmed by people that are in careers, for example, nursing, and they say it’s not a STEM career. I think that we need to be really mindful of the fact of how people or what people think is something that is and isn’t related to STEM is really important for consideration, including many of the social sciences, right? So subjects like psychology, whether it’s neuroscience or other aspects of psychology—topics that are, in some people’s minds, very much science and other people not so much.

So, if they're too narrowly defining science and what counts for science, they may not see themselves fitting in it.

McCreedy: Exactly.

How are you currently measuring identity in your work?

McCreedy: I'll be very fast, because right now I'm not doing any studies. We'll look at that in the Hadron Collider project, some more thinking about that, but right now I'm not, actually, engaged in any research.

You can talk about your work with Cascading Influences. Lynn started to talk a little bit about the personal meaning maps, or any way in the past that you thought about identity and collecting data for that.

McCreedy: Lynn and I spent a long time really trying to be strategic about how we get this information, and what we were trying to figure out; this was a preliminary. This was just a first pass at this effort, because we were identifying girls from a variety of projects. The unit of analysis was not the projects, but girls having been engaged and involved in a project, in programming that was targeting girls and women in science. And so, it was very much about trying to look across different ages, different kinds of exposure, different experiences, and thinking about how that had made some sort of difference.

They had 20 points they could distribute across a series of responses about what was influential to them, and who was the most influential. For example, let's just say there are five rows. One row would be "made you think about yourself as a scientist." Then, on the X axis would be your parents, your facilitator, your peers, etc. It was about trying to dig into identity questions; how do you think of yourself, and who was influential in that, and in helping you think about that? What I loved about this was we really created this question and it was nowhere else, and we weren't really sure it was going to work, but when it came to things like "what made you think about your race" and "who you were," the heavy influence was on parents. "What helped you think about science and technology, and engineering and math" was often either a teacher at school, or an after-school facilitator.

For me, that was a really unique way to identify the ways in which these programs were enhancing identity, and also confirm, in at least in what I was sort of imagining, who were the influencers in areas that maybe our projects weren't. It all played out in a way that realized what we might have expected would happen. And so, I thought that was a unique approach to looking at identity.

Dierking: The first thing I would say, and I know it's probably not the case, but, actually, I was a little nervous when I saw that this is the evaluation and measurement group. Even the notion of measuring identity; I don't think of the identity research that I do as measurement. But, having said that, a lot of the work right now is very close work, perhaps where one is in the case of Designing Our World where there were videotapes of girls interacting during engineering activities, and trying to make sense of that. In that study we used [Carlone and Johnson's notion of identity](#) with the notion of competence and recognition and performance, and, have tried to create a model.

Again, the group really has talked about three dimensions of an experience. There are activity frames, the way the activity is, shaped by the practitioner. It's going to be interesting with the next question. But is this experience or activity about competing? Is it about collaborating? Is it about getting the right answer, or is it about being able to fail and see that as a positive thing? Looking at these situated identities and, interestingly, in this case, not looking at STEM or engineering specifically, but seeing what roles girls take on within these groups. Are they the leader? Are they the helper? Does the facilitator do the set up or do the girls have opportunities to decide?

Then looking at critical moments. This is where facilitation is critical. Are all girls being given positive feedback for what they're doing? Are those girls who have taken charge getting more positive feedback from facilitators? There's that really close work where you're looking at video, and you're coding it, and trying to understand what's going on. Again, with the YESTEM project, youth are ethnic graphic portfolios that we will then be able to talk to them about, and try to understand. In that project, because practitioners are a very important part of it, we're also going to be creating practitioner ethnographies and trying to look at those as well as important data.

In the case of Synergies, we've done in-depth interviews with case study youth in their homes, and really had an opportunity to hear them talk about experiences and see how they're connecting them. One of the things we're looking at are peers. We've talked about critical adults and important adults, but certainly in the middle school years, peers are really important too, peers and mirror peers. So, we're trying to figure out, who do you do this with? Do you have parental support for it? Does your teacher support you? So, we're stepping back a bit, but we know these youth very well. And, then, finally in our questionnaire, "tell us about yourself," that we give once a year to youth and have them complete.

We are asking questions, again, about what's an interest that you have. Now, is this something that you've been pursuing for a long time? Who are you doing it with, and so forth. So, we're trying to have the very close, in-depth qualitative interviews reflected for a larger sample with this questionnaire. So, I guess it's sort of a mixed bag, in terms of what we're trying to do.

Do you think it's possible to create tools for measuring identity that practitioners or evaluators could easily use?

Dierking: I would step back and say is this a tool for the practitioner to figure out the identity, or is this a tool that helps a practitioner support identity building. Dale was very modest about "I'm more of a practitioner." She was very engaged with the research that we did with Cascading Influences, and collected a lot of the data, and helped to make sense of it, and analyze it. I call them research practitioners. I even think of myself, sometimes, as a research practitioner, because I like to do work on the ground, and I like to be able to see how it connects. I think for most practitioners I would suggest that what we're trying to develop are tools that will help them understand identity, help them see that they have a critical role in supporting that, and then providing—maybe it's video showing them types of interactions.

[Designing Our World](#) needed to have a dissemination piece. We're developing a guide to help practitioners support girls' identity in engineering and doing a series of workshops. It's helping them understand the value of identity. Going back to our second question, why we know it's so important, and helping them get excited about this. As I said a few moments ago, thinking about those critical moments, and what their response is, and how they can shape a moment and an experience.

There's pretty good evidence that most girls flourish in collaborative spaces and doing collaborative things. If the way the activity frame is set up for the experience is in a competitive way, that's going to turn off some of the girls. So, having practitioners really think about how am I building this activity? How am I helping, in this case, girls know what the activity is, why they're doing it, how they're doing it? And then, being a skillful facilitator to draw out girls who, perhaps are sitting back because there's a really strong leader who's taken over the group.

It's funny, we all know the data that shows when boys and girls are in the same group that sometimes boys take over. Well, I'm here to tell you that in all-girl groups the same things happen. So just helping practitioners realize that those simple facilitation moves, or moments—and decisions they make, really have a profound difference on the development of identity, I think is really important.

[Dale McCreedy left call]

Dierking: With evaluators I think one can develop some things to look for, and look at, that they could bring. Ideally, evaluators and practitioners are working together, it's hard sometimes when you're in the midst of facilitating to understand the choices and decisions you're making, but if an evaluator, or even a fellow practitioner knows what to look for. It's just how do these groups interact, and what do they seem to think this activity is about. I think that's possible.

I think what you're saying is that it's hard to capture without thinking about the other things that are going on that might influence identity at that moment, or in that setting.

Dierking: Yes.

In your work do you think about how other identities, such as gender, race, socioeconomic status, etc., might overlap or intersect with science identities? If so, what role, if at all, do you think this intersectionality played in your work?

Dierking: It's hugely important and very difficult in some ways. It's even a step beyond trying to measure, or think about, identity. But, it's very much a part of the work we're doing with Synergies. It's absolutely a part of what we're doing with the YESTEM project. We're looking at it at two levels. We're looking at the macro level. And we're trying to identify high-level practices, which is this area of work was first explored in classrooms. We're trying to see if we can identify high-level practices for practitioners that support youth being able to create their own pathways in and through STEM. And, at the macro level we're trying to understand are there issues of access. Are there activities you would love to engage in, but they are costly? Are there situational things going on?

In the Portland project, we're going to be working with the community called Woodburn, which is outside of Portland, but in the greater Portland area. There are girls who live in homes with undocumented parents. We discovered last summer that made a huge difference in their willingness and ability to participate in a summer Girls Incorporated experience called [Eureka](#). They didn't want to leave their homes because they are the major speaker of English in the home. They understand a little bit about how this works. And, they were petrified that ICE might come to their home. And so, they were unwilling to participate in a program that took place at a community college in Portland.

These are huge issues at the macro level, but we also want to look at the micro level. This is where the work of Designing Our World is really important. At the level of youth engaging together, are certain kids privileged in terms of their participation? Does participation require equipment or skills that youth might not have? We're looking at issues around social capital and, because Louise Archer is working on the project, we're also looking at this construct of science capital. It's critical to think about how intersectionality influences identity building and identity making.

Do you have an easy way of explaining what science capital means?

Dierking: Science capital includes a family, parents, guardians, grandparents who understand science. They may not, as Dale said, know a great deal about it, but they know it's important, and they know it's important for their child. So, they support that. It could include supporting kids' hobbies and after-school and weekend and summer things. And, trying to help them choose science-focused experiences. It could be watching science television, if one has a television. Watching science television with your child.

It's a series of things. Some families have a lot of stuff at home, and an understanding that you can open up a cupboard and pull out some vinegar and some baking soda and make a volcano. That may not be the common understanding of some families. I think it's really important to try to build that a little bit.

One of the things we did this past summer with our Synergies project is we developed mini grants for families to apply for. We ended up having eight families that came forward. They had to agree to two things. One is that they had to talk to their child about what they were interested in within STEM. And, they had to be willing to talk to us after these experiences long-term. Each kid got \$100 worth of "science stuff" we called it. It was tailored to each of the youth's interests. We bought microscopes for some youth, a lot of engineering kits, really cool stuff, and it was so much fun to deliver these bags to the youth. But, speaking of science capital, something that's been interesting is some of the youth have had the support of their parents, and or, guardians, to keep pursuing this, and maybe taking the kit and doing something different with it. There are other youth for whom it was great. They had a wonderful time, and two weeks later, what do I do now? And, some of that, I'll be honest, was related to the material. Actually, microscopes ended up being this great thing. Oh, I have a microscope. And, we made sure we bought them some prepared slides, and we also gave them slides that they could make their own slides, and gave them ideas about them. But, it was sort of like they did that, and what do I do next?

So, one of the things we're trying to do with these youth is identify people in the community who actually use microscopes in their work and see if we can build some mentoring relationships. And also, we are talking to the high school zoology, biology teachers about are their youth who would be willing to be a near peer for these youths. And, it shows you, again, I think, that's related to science capital. Great, we got this kit, but what do we do with it next?

A lot of people are talking about things like interest, motivation, and attitudes as outcomes for science learning. How do you think these connect with identity, and how do you distinguish science identity from these other concepts?

Dierking: Well, you know, it's interesting. Our construct for Synergies, is around interest and participation. And, we are using the [Hidi and Renninger Four-Phase Model of Interest Development](#), which, actually, I find very helpful in my thinking, because it's not just about a youth or a child liking something. It's a much more robust construct, and in fact, what we've done in this questionnaire is build in these other dimensions.

One of the dimensions is competence in the topic. Another is feeling like this is a valued topic. It's relevant to my life—feelings, again, related to competence of self-efficacy. I think they are critical parts of interest, and I think interest is a critical part of identity, if only, for the fact that it means that youth, STEM in this case, are still engaged and participating in activities that will help them further identify and build that science identity, whether it be a hobbyist, belonging to a rocket club, or an amateur astronomy club later in life, or choosing to pursue some kind of a STEM career.

So, for you, these are very tied together?

Dierking: They're tied together and, I think, they are outcomes. It's been interesting that some funders, I will not name them specifically, when trying to use those as outcomes, sometimes pushback and say well, what about learning, or what about concepts. And, to me, it's very hard to separate those, and I think if we can keep youth engaging and participating, I feel like—and probably this is why I am a free choice, informal person—that they will be learning and experiencing. Something I think is really important, and it's a big part of the Next Generation Science Standards is yes, science is about knowing stuff and being able to say no, I don't know that. But, science is also a set of practices and tools and ways of looking at the world. And so those are outcomes as well. So, it's not as neat and clean. I've never been a big fan of reductionism, which, certainty, and controlling variables, because my feeling is that it's the variables that are really the interesting part of trying to understand what's going on. I think that's going to be really important in this YESTEM effort to think about how can we identify high-level practices at the macro level, and at the micro level, that really empower youth to explore, ask questions, be critical thinkers, all those pieces of science that we know are so critical.

That must be why I also like the free choice base, because, to me, some of those are so much more important than sometimes the content.

Dierking: By the way, I would say that that doesn't mean that youth don't learn content.

What are some examples of resources, or tools, for measuring or understanding identity that you have found useful? Are there some people or projects that you would recommend?

Dierking: I think that there's a lot of work in progress with the goals of having some tools. Again, I mentioned it a couple of times, but the work that Scott is doing. Actually, Dale mentioned [LEAP into Science](#)—they just received an Advancing Informal Science Learning Grant. It's a little bit like Designing Our World. We're going to be looking at the research piece, which the Institute for Learning Innovation is conducting, and Scott's the lead on that. Looking at the family as a system and trying to understand that. The ideal would be there might be some tools for parents too, related to what I said earlier. Tools for appreciating that parents are critical to identity development in their children. There is a lot of evidence that they're more important than many of the other factors, with the exception, perhaps, of peers and their peers. So, I think that there's going to be some important work that comes out of LEAP.

Is LEAP, is that's Scott's project with Head Start and Engineering, or is that something different?

Dierking: This is different. It's actually Dale's project that was at the Franklin Institute. Her colleague Julia Skolnik is now the Principal Investigator for Leap into Science, and it's a project linking science with literacy for young children, working with libraries, and science rich institutions, and providing activities and experiences for families. And, what we're going to do is look at interest development across a set of families, and look at the role that their interactions play.

So, in this case, saying the important facilitators are families. I'm really excited that, hopefully, Scott will get funding for the Head Start to Engineering project he just submitted to further play around and tweak this model about activity frames, situated identities, and the notion of critical moments. Because, again, I think these are great for our understanding of identity. It would be further refinement, and can result in tools that practitioners will have to be able to understand what's going on within the group dynamics. Be they facilitators of an after-school program, or be they parents at home working, doing something together with their children.

What is STEM Identity? An Interview with Heidi Carlone

On November 28, 2017, [Jamie Bell](#), Project Director and Principal Investigator of the Center for Advancement of Informal Science Education (CAISE), interviewed [Heidi Carlone](#) to understand her thinking and work on the topic of STEM identity. Dr. Carlone is the Hooks Distinguished Professor of STEM Education in the Teacher Education and Higher Education Department at the University of North Carolina, Greensboro. Dr. Bell conducted the interview on behalf of the CAISE task force on evaluation and measurement.

A video of Dr. Carlone's interview, as well as interviews of other researchers, is available at InformalScience.org/identity.



Tell us about the projects you've done, or are currently working on, that focus on identity.

Since 2000, probably every study that I've done has to do with identity in some form or another. I'll give you a few examples here. I've looked at a comparative ethnography of two groups of high school girls in physics. One group taking a traditional course, and one group taking a reform-based course. And looking at their meaning-making in both courses, we had some interesting results there, in that the girls embraced the traditional approach and resisted the reform-based approach. And, the construct of identity helped us understand what was going on there.

Another example is a comparative ethnography of two fourth-grade classrooms. Both teachers who taught each classroom were equally committed to reformed-based instruction. Students in both classes claimed to really like science, but students in the different classes affiliated with science differently. In other words, the girls of color in one class were really strongly saying, "I like science, but I don't want to be a scientist," and "I'm not like the science kids in this class." And, the other class just kind of uniformly adopted and took up this identity that was being promoted in the classroom. So, again, there we had this construct of identity

helping us explain how two really great teachers, doing hands-on, minds-on science could have outcomes that were really different in terms of identity.

Another example is the study of diverse high school students who did not, necessarily, fashion themselves, or unevenly fashioned themselves as science people. Some of them really affiliated with science, and others just came because their parents thought it might be a good way to spend a week in the summer. This was a longitudinal, this was a study of students in field ecology. It was a field ecology enrichment program, which had out-of-school components and summer components. And, these students, these youth, really did not affiliate with overall, they fashioned themselves as “I’m not a snake person. I’m not a reptile person. I’m not an outdoors person.” And, through the course of the week, and some follow-up days, they begin, kind of, playing with this notion of, “well, maybe I am that kind of person.” So, we noted this idea of identity boundary work. Or, how does one define oneself as in or out, and what are those spaces of where they might intersect as both in and out? And then what are the structures that support that kind of identity boundary work?

We’re getting ready to publish a series of articles about elementary students as they engage in engineering. And, we’re also doing a longitudinal study of those students, those high school students, in the field ecology course to see whether or not, and what ways, those kinds of really finite triggered experiences in field ecology may, or may not, have had some sort of long-lasting effect on their STEM-related identity work.

We also have one more project, a new project, funded by the National Science Foundation, that’s going to be tracking middle school youth STEM-linked identity work, as they participate in a series of after-school and summer enrichment programs that integrate science, engineering, and computing, and focus on socioenvironmental problems. So, I’m sticking with this identity construct, even though it sure is a murky and difficult terrain.

Which program funded that project you just mentioned?

That one is [NSF iTEST](#). It’s called [Bridges Broadening Identities for Diverse Youth in STEM Through Socioenvironmental Problem Solving](#).

Do you work from the same definition of identity across projects, or do you define it differently, depending on the context?

I make certain assumptions about identity in most of the studies that I’m doing. So, it’s really difficult to provide a simple kind of definition for identity, and it’s easier for me to think about some assumptions that I’m making about identity that help me operationalize it, and make it concrete for my studies.

Overall, the first thing that I would say is that my work examines identity in concert with the study of culture. So, I cannot completely address the question [of] who an individual is becoming in a setting, unless I also address the question [of] who are youth obligated to be in the setting. And so, I’m always looking at individual’s performances in relation to what the setting demands, celebrates, and marginalizes. Those two things—I’m looking at those things together.

This idea that identity is studied in coordination with culture, in doing that I'm making assumptions. So, let me draw out those assumptions. First, I make the assumption that people are formed in practice. Asking a question, like, "what does it mean to be smart? What does it mean to be struggling? What does it mean to be a discipline problem, a genius?" The meanings of these—the answers to these questions—are context-dependent. The labels of self and labels of others are only helpful if we understand the local context—the obligations, and the norms, and the practices that are celebrated and marginalized in those contexts.

One must also understand not only the local context and what's demanded there and how that implicitly positions certain kinds of students and youth (and celebrates some performances and marginalizes others) but we also have to look at macro-level structures. This is another kind of aspect of the work. That's the first thing, that people are formed in practice.

Then, a second assumption that I make is that identity outcomes of any given set of practices, or any local context, are often heavily shaped by larger social structures, like race, and class, and gender. These societal structures constrain, but they don't determine, an individual's STEM trajectories and pathways. People have a choice in who they become, but it's not an unrestrained choice. So, that's another tricky part to this, that despite the power of larger social structures, people, actually, can author themselves in really creative and imaginative ways. This aspect of studying identity makes room for cracks of possibility, and agency, and transformation.

So, to summarize what I've said so far, these perspectives highlight the explanatory potential of identity, and that's why I love the construct. I keep saying to myself, and maybe I shouldn't say this on this interview, but it's absolutely honest. I keep wondering whether or not I should give up this construct of identity, because it is so murky and complex, but it has such strong explanatory potential, because it opens up this space and tension between structure and agency.

The other thing it does, it allows us to pay attention to multiple time scales. Now, so, we have multiple contexts. So, it's what's happening locally and what's happening cognitively for the learner; and then what's happening locally, in terms of the local cultural context, and what's happening more at the macro level that's been historically enduring (so, those kinds of things). But, it also allows us to look at historical, local, current, immediate future, and generational futures. These different time scales, okay?

So, studying identity might involve paying attention just to moments of authoring one's self in imaginative ways in a setting. Okay, that could be one way to do it. But those little sparks, and imaginative ways of offering oneself, might lead to more enduring changes over time that become habitual performances. So, that's more longer term. And, those habitual performances maybe have the potential to influence the culture in which those youth are performing, which then can change the meaning of what counts as a science person, and become resources for generational kinds of transformation.

It's ambitious to think of it that way, but I do think thinking about identity has this kind of potential for understanding multiple time scales and multiple contexts.

When I study identity, what am I thinking about? I have to say I've been struggling with this one lately, because I am trying to look at identity longer term.

However, I do kind of want to emphasize that identity isn't a final form achievement. It's not a static accomplishment. So, in many of the studies I discuss this idea of identity work, and this is the way youth position themselves, and get positioned in relation to the normative practices in a setting, or in relation to social structures. Let's [say] an example of this would be a youth who gets positioned as a good science participant in a setting. And that—what that means is that person is able to, and willing to, fit in, or see oneself inhabiting the celebrated subject position, this kind of ideal science student in a setting. And, these are cultural models for who counts as a legitimate science person, and what counts as legitimate scientific performances in a setting. And, these are shaped by historical and local practices.

This is the kind of work that students have to do. Kind of, what is the celebrated position, and how do I fit into that? Do I even really want to fit into that? And, in what ways am I going to perform myself to do that?

To get really concrete, what I've talked about so far is a lot of theoretical assumptions, and it's hard for new researchers to take those kinds of big ideas and put them into concrete, "okay, I've got it, blah, blah, blah." Identities are formed in practice. Tell me how I go about it if I'm entering a classroom setting, or an out-of-school setting, or a really innovative after school program? What do I look for? How I know identity when I see it? Well, you know, you're keeping these other principles in mind that identity is not just an individual construct, right? But, you can also look at individuals and what they're doing. And that gives you hints about how the individual wants to and/or is performing themselves and doing the identity work in a setting. One is bids for recognition. Who are they trying to get attention from? What are they trying to get attention for? Holding the floor is another one. These say something about what the student think[s] counts in this setting about whose favor they're courting, what is worth speaking up about, what is worthy of celebration or derision. Those two things are really nice things to look for when you're in a setting. Another thing that I look for is others' positioning of a youth. So others' positioning says something about the success of their bids for recognition. So when someone's holding the floor and others ask questions of that student, they're taking up this kind of local expert identity that others are also recognizing.

Another great identity marker in a setting is conflict. I like the construct of conflict because it helps identify how there are conflicts in what the setting demands and how the youth want to position themselves. And so those kind of tensions help illuminate both the culture of the local setting but also the identity work that the youth are trying to do to either fit in, resist or, you know, transform the setting.

Those markers above are also helpful for me to study identity longitudinally. We found some youth make similar kinds of bids no matter what the context. That gives us hints about their habitual performances and their more thickened identity work over time. The interesting thing is that those performances can take on new meanings and new settings so that who I am in fourth-grade science, for example, as someone who claims space and claims voice and participates is lauded and celebrated in this one setting, but those same performances, especially if I'm an African American girl, can take on shades of being difficult and argumentative and loud instead of being a productive member of the group.

Those are some things that I think about as I think about how I'm defining identity and how I go about studying it.

To make explicit the assumptions, I think, is probably more helpful, in some ways, than having a definition, because a definition can be complex and difficult. And the markers that you mentioned as being the trackers or indicators of what's developing in the youth.

Could say a bit about how other identities like gender, race, socioeconomic status, and other factors intersect with STEM identity?

I think that most of the stuff that I've already said aligns with that, as we're thinking about identity and the fact that identity is not constructed solely by the individual. In early work we looked at three major constructs that define an identity. If we're again looking at what matters for STEM identity trajectories. We looked at performance, competence, recognition of self, and recognition by others. That was [the work that I did with Angela Johnson](#). And, in that work, what got highlighted was the importance of this recognition by others, and recognition by scientific others, and the ways that could either thwart—well, it's not either/or—could both thwart and/or encourage women of color science trajectories. I think understated in that was the role that race, class, and gender played on the women's trajectories. We did try to do a good unpacking of that but we did a better unpacking of that in an article Angela took the lead on, on intersectionality. So we really tried to look at how and why did women of color move through and work through all of the difficulties and unascribed, undesirable ways that they were getting positioned. How did they work through that? And so I think that we really looked at where they were located along the matrix of oppression. I like thinking about this idea of a matrix of oppression because if you're a white woman from an upper middle-class background you have one kind of set of issues to work with and one or more sets of larger social structures to contend with as a woman in STEM. But if you're an African American woman who is a lesbian and from a working-class background you're located very differently along a matrix of oppression than a white woman from an upper middle-class background. You're facing a lot more kinds of ways to be oppressed, marginalized, and there are so many ways that you do not fit into the kind of historically celebrated ways of being scientific. And so there are a lot more ways to be thwarted along your trajectory because of that.

What about socioeconomic status? Has that come into your work?

We haven't done a lot with socioeconomic status, but we've done some. The best example that I have is a study of boys' trajectories. We looked at scientifically talented boys, four boys from fourth grade to seventh grade, and we looked at their identity work as they did school science. What we found is that there were some intersections of class that thwarted one of the youth's trajectories in that his way of performing himself was very aligned with a hyper authoritative, hyper masculine way of performing himself that actually didn't play well with the desired model of masculinity in these settings, which were performing muscular intellect. This cool, confident, doesn't really matter, "it's okay, whatever, I got this," kind of identity, which did not align at all with the ways the boy from the working-class background was wanting to assert and power through and get his ideas well-known in an authoritative way. This kind of preferred masculinity with the muscular intellect was less—was not as accessible to the boy from the working-class background. He just couldn't manage that.

Either he didn't want to do it that way or it wasn't a fit for who he was and what he thought needed to happen in that setting.

To help others who may be approaching this for the first time or just beginning to think about differences of approach, is your work different from what you know others are doing? In terms of how they may be defining it or the assumptions they may be making...

I think there are other people doing what I'm doing, but I don't think that it is widespread. So I think the major difference or the major distinguishing aspect of my work that others share too is that I approach the study of identity tied to the study of culture, and so in doing so, I'm eschewing individual explanations for problems that are inextricably connected to local and global contexts. I have to say that that aspect of doing both at the same time has become a little bit problematic for me, thinking about studying longitudinally. For example, the work that we're doing in studying youth's identity work as they're narrating it, three to five years after [the HERP project](#), which is the study of youth's identity work in the field ecology enrichment program. We were able to study the norms and practices and the culture of the setting there, but then we're asking the youth to narrate their meanings of those experiences three to five years later. So I'm asking them and really getting a sense of their meaning-making, which is much more cognitive than cultural, three to five years later. That's forced me into a different way of thinking about and identifying identity than has been in the case in my previous work.

How are you measuring identity in your work?

In that original model that Angela Johnson and I came up with, we had this performance, competence, recognition of self, and recognition by others. If you would have asked me how I'm measuring identity five years ago, I would have been like, "uh, I don't measure identity. I am an ethnographer. We don't measure, you know." And yet there has to be some accounting for, even if you just give all the caveats and say okay, these are just snapshots, okay? We're gonna try to figure out in the moment how to capture or characterize the identity work that youth are doing and then over time what kind of identity work are they doing.

So my biggest challenge right now about capturing identity, because I don't want to use the word measuring, is—and characterizing—is identifying what constructs are prominent for youths' meaning-making of their experiences in these science programs. I'm just gonna use the HERP project as an example. What seems prominent for their meaning-making? We started off riffing on this performance, competence, recognition model. I said, okay, let's unpack that a little bit more. Let's look at disciplinary engagement and competence. I still think this idea of engagement in disciplinary practices is important. And how they engage and kind of what they're being held accountable to be engaging in. Recognition of self, still important. Recognition by others, still important. There's also this disciplinary agency, e.g., can they take up these practices and use them in their everyday life and/or in their STEM trajectories as they kind of move over time? This idea that they're taking up their knowledge, experiences of the work that they did with the HERP project, and can and do they apply it to new settings? Did they see it as relevant, et cetera? So that's another one. We've got disciplinary engagement and competence, recognition of self, recognition by others,

disciplinary agency. We also have this idea of social affiliation and belonging, which is “are these my kind of people? Do I fit here?” And then there’s this other one about habits of mind that was these were the original six—these were the original that I riffed off of the original. So these are the next iteration, the six. Those are the competencies—or the kind of components of identity—that I thought might become relevant to youths’ storied meaning-making about the HERP project. It turns out that—we’re still in the middle of this study, by the way—some of these are becoming way more prominent than others, just as a preliminary hint about our findings. I’m not finding a lot about habits of mind, for example, and our program may not have cultivated that. But I’m finding a ton, even for youth who don’t want to pursue science as a longer-term endeavor in a disciplinary way. They now have pets that are amphibians and reptiles, and they have worked in this kind of field ecology thing into their lives. They go herping on weekends, et cetera. But, interestingly, for almost all the youth this disciplinary engagement and competence becomes a primary way that they’re storying their experiences, even three to five years later. And we know that. They’re not just talking about, “I remember when I did that activity where we went out at night, and we were looking for frogs.” No, they’re like, “oh, I remember when we did the frog hunt, and we were doing the calling amphibian frog protocol, and we were identifying the different frog calls.” For example, now I can identify a spring peeper, and they were identifying the actual species and the way that the frog call sounded, and they could really pull up some really specific examples of those disciplinary practices three to five years later, which I thought was fascinating.

Those are the six components that I was looking at, and we’re in the midst of deciding which of those are becoming more prominent for the youths’ meaning-making. That’s one way we were looking at what was triggered by the HERP project. But we’re also looking at identity over time. So we’re looking at historical disciplinary identity, triggered disciplinary identity, i.e., what they come with. What they came to the setting with. We have that data. What got triggered with the HERP project. And then emerging disciplinary identity, i.e., do they take what happened in the HERP project and pursue STEM opportunities that they wouldn’t have otherwise pursued had it not been for their HERP experience? So, some of them joined a club that they wouldn’t have joined. Some of them joined another summer STEM program. Some of them pursued a scientific major that they wouldn’t have pursued. Some of them decided to get a salamander as a pet. So different kinds of ways. And then we have the sustaining disciplinary identity, which becomes much more thickened and stable. Kind of like claiming the STEM identity. Like, “I’m a science person through and through and this is what I want to do forever and ever” or “I’m not gonna pursue this as a career, but herping will always be a part of what I do with my family and/or my future kids.”

Those distinctions are really, really helpful as a model for thinking about how to measure and parsing the different aspects of it like that. I’m thinking about the other constructs that we’re also going to be conducting interviews about in the future, some of which are motivation and interest. I wonder what you think about those and if those are useful in terms of intersectionality?

I think they’re useful. The differences between those constructs like interest—although interest I still think is part of the identity work too, by the way, and so is motivation—any of those kind of more psychological constructs, the difference for me—and I don’t know if

educational psychologists or learning scientists would argue with me about this, and they might and that's okay—is that they feel much more. They're much more cognitive—what's between the ears. And if you think about the tension between agency and structure—like how people position you and how the norms position you and how you position yourself and how you think of yourself—so if you think about that tension between the individual and the context, the motivation and interest feels to me like it privileges the individual above all else, right? Yeah, the context influences it, but at the end of the day what's most important is the individual is the driver. And I will admit in some of my studies—and this has been still an ongoing struggle with my work—is that sometimes in my work the structure becomes too deterministic. So the individual's agency is squashed a little bit. In some of my colleagues' work, I think the individual agency gets blown up. Like these moments of beautiful identity work get blown up, and I'm wondering about really the significance of those individual moments, over time.

So I do think that if I'm thinking about interest and motivation, it feels like those don't account as much for issues of power or issues of race, class, and gender. For issues of historical ways of doing things it privileges the individual in context. It's still important.

We found a real continuum across the folks we've interviewed about identity in terms of what people believe is inextricable or what happens in a moment versus over time and how the other factors like culture, a key point, play into it.

Are there resources or tools that you think people should be aware of as they grapple with this construct? Any particular scholarship?

I have lists and lists of scholarship. I am intrigued and inspired by [Zahra Hazari's work](#). What I like about her work is she's trying to do this large scale. It's complementary to my work, which is so local. She's worked with some of the constructs that we've worked with and says, okay, how can we develop a survey where we can take these snapshots but that are informed by the ethnographic work that my colleagues across the country and I have been working on? So I am intrigued by that because it's not a competition. It's not a clash between trying to understand this construct in a larger scale with larger-scale populations and with smaller scales. I think her work feels really complementary with the work that I've done and very respectful of it, and I also respect her work. I'm learning from her work as I'm trying to do what she's doing on a little bit of a smaller scale. I think that's the number one person right now that is inspiring me to think about my work differently.

I'm wondering about the articles that have come out of the HERP project. I looked at the website while we were talking, and the [project description](#) of HERPS on [InformalScience.org](#), and I noticed that there was a [Connected Science Learning journal article](#). Have there been other products out of there that we don't know about yet or are coming out?

Well, we have two articles that we're working on this semester, but we do have [one article in International Journal of Science Education on the identity boundary work](#). I can send you that reference. And then we have a couple of book chapters, so we're still kind of cranking that out.

Are there any books on identity that you've found useful?

Well, I really like [Maria Varelas's book](#), which is a compilation of researchers studying identity. The only thing is that I worry about [in giving examples out of context] is that here's how I did it, and here's how I did it, etc. We're not making clear what the underlying assumptions are about the different ways of studying identity. So what do I gain—for example, when I'm studying identity in ways that are intimately tied to culture and what am I losing, right? What am I able to see, and what am I not able to see? And so I think there needs to be some sort of guide moving forward about conceptual differences in how to study identity and what are the underlying assumptions. If you're studying identity this way, what are the taken for granted assumptions you're making about learners, context, learning—and a good education is another thing, and a good informal space, for example. And then what do you gain by studying it this way, and what are you ignoring by studying it this way? And so accounting for those differences, I think, is really important. So I love the [Learning Science in Informal Environments](#) National Academies' Report. I thought that was really, really well done. But we're still not there yet. I don't know. The thing that I use the very, very most is Lave and Wenger's 1991 [Legitimate Peripheral Participation](#). I used that as a launching pad to thinking about this notion of identities in practice, and my second one is Dorothy Holland's [Identity and Agency in Cultural Worlds](#). It's 1998 though, right, so it's time to work on thinking about continuing that work. Did you interview [Margaret Eisenhart](#)?

We didn't. It's interesting you bring her up. When I was in graduate school I was such a fan of her work. But that's a good suggestion.

She was my advisor. And then Dottie Holland was her advisor. But she's much more culture than identity. She's at Colorado, Boulder. But she's retired now. But she's still working.

Is there anything else that you wanted to say about identity?

One of the things I just thought about as you were talking about resources and people whose work inspires me, I also want to mention, and somebody's probably already mentioned this before, but the recent special issue from the [Journal of Learning Sciences on disciplinary-linked identity](#), that was outstanding. Every article just blew me away. I did one of the commentaries on the articles, and the reason why it was interesting is that I think it represents the next—and I have to say scary iteration—of one strand of this identity work in that it's not going to be okay just to look at what a setting does and study the unfolding of identity work. That work is much more design-based research and actually a social design experiment, which is much more critical. We know that these are the things that keep kids away from STEM. We are going to design settings that explicitly contest those historical meanings of STEM and STEM person. We're going to pop it in the face real quick and put it out there, and we're going to study what happens in these designed settings, these revised designed transformed settings. It is incredibly ambitious work, but it is also really both theoretically rich and kind of practically inspirational. So I am really intrigued by and inspired by the work that's represented in that special issue.

What is STEM Identity? An Interview with Zahra Hazari

On November 17, 2017, [Mac Cannady](#), Director of Quantitative Studies at the Lawrence Hall of Science, interviewed [Zahra Hazari](#) to understand her thinking and work on the topic of STEM identity. Dr. Hazari is an Associate Professor of Science Education at Florida International University. Dr. Cannady conducted the interview as a member of the Center for Advancement of Informal Science Education (CAISE) task force on evaluation and measurement.

A video of Dr. Hazari's interview, as well as interviews of other researchers, is available at InformalScience.org/identity.



Tell us about the projects that you've done that focus on identity.

The very earliest project, and a lot of my background, is in quantitative work more than qualitative, although I have done a lot of mixed methods work as well. We focused on looking at how we could measure identity and really thinking about theoretical framing. This was a lot of back research that was presented in the [2010 paper](#) and a couple of [other papers](#) after that. We were the first to really think about how to quantify our thinking around identity development, and how we can take qualitative work with theoretical framings that were developed through qualitative work to think about how to measure these things from the student's perspective.

That was the early work, and since then, I've followed up with lots of [case study](#) work where we were trying to understand how identity development happens in the classroom. We used the quantitative work to identify classrooms where we saw shifts in student's identity, which saw growth in my area, specifically physics, so we were looking at physics identity development. Looking at those classroom case studies, we really started to understand how this was playing out for students, how students were conceptualizing their identities within these classrooms, and for many of them it was the first time they had learned physics or been exposed to physics as an independent discipline. It was interesting to see how they were conceptualizing not only their own identities but also how teachers' practices, and what was happening in the classroom was mitigating that development.

So across these projects that you described, how do you define identity?

That is a very interesting question because people define identity in many different ways, and this is a very dynamic space. The way in which we've conceptualized identity is really how students identify themselves with respect to a particular discipline. I'm not talking about identity in general, but I'm talking about disciplinary identity, so how they identify with respect to a certain discipline. If a student says something like, "Oh, yeah, I see myself as a biology person, but I'm really not a physics person, but I think I am a math person." That's the kind of language we look for as well as other ways in which they articulate how they see themselves and how they identify themselves with respect to a discipline. We're really focused on the idea of disciplinary identity and how people develop disciplinary identity.

How do you think that matters for science learning or for science communication?

[In] any model or any theoretical framework, the value in that framework is that it's predictive of what students are going to do and the choices they're going to make. One of the reasons we focus on identity is really that pragmatic approach because we found that our measures for identity are so strongly predictive of people's choices. It's predictive of how they engage with the class, it's predictive of whether they're going to take the next class, it's predictive of whether they're going to choose this as something related to something they want to do in their future career—how they envision themselves in the future. It's related to all of those things for students, and because it's so strongly predictive in our models, above and beyond so many other factors we've tested, we really feel very confident that it is a theoretical framework that can provide a lot of understanding about how students make choices, and why they make certain choices. This is why I think it's really important in general.

In science communication, there's tons of working your identity space in terms of discourse identity that a lot of identity development happens through social interaction. In our conceptualization, identity has to do with how people recognize themselves fundamentally. [However], that is mitigated by how they are recognized by others as well as their own interests, like how much they're engaged in the topics they're thinking about within the scope of the classroom or even outside of the classroom. Whether they feel confident that they could do this, work in this topic or that they could accomplish things they need to accomplish.

So those are the ways in which we think about it. But that "recognition by others" piece is a big piece in identity development and that often happens through communication. It often happens through discourse, through talking to others, through sharing their ideas, and being recognized for those ideas that they have.

Science communication is really very fundamental to identity development and on the other side, I think science communication when they have access to interesting work in science, when they're reading about their work that's being put out in science, and it's accessible to them, that can really play into the interest dimension.

Many people when they think about identity or they work in identity, they only look at the social performance aspect, and they only look at the recognition aspect of it; and for us, we take a much more holistic approach to that. How does one recognize oneself as being part of

this area or identifying this area or this discipline? And that doesn't just have to do with recognition. It also has to do with their interests. We've interviewed students where they will say things like, "I'm not really recognized in this space," or they don't really talk about recognition events, but they're so deeply interested, and a lot of that comes out of informal science. They have been engaged by science programming by NOVA programs or by other informal science programming, and they have really been engaged and interested and captured by those topics. They start to see this as a fundamental way in which they like to think about the world. They see themselves. When we think about sources of self-recognition, things that lead to students seeing themselves in this kind of a way, recognition by others is really important, but interest is really important also. The feeling that they can do it is also important.

That's really insightful and much appreciated. You started to talk about how other people approach identity and your distinct approach—can you expand on that?

Many of the identity researchers who have done groundbreaking work—and we draw on a lot of their work because it's very, very insightful and nuanced—but some of their focus has to do with the social performance: What students are doing. This is identity. How they're being recognized by others in those actions and in that discourse, not as how they define identity. A lot of it is around the social performance and how other people are recognizing that social performance.

The reason why we've taken a different approach is because of the data that we collected where students don't always perceive the recognition of others. I always like to take this hypothetical case where suppose you have a student who is autistic. They don't pick up on social cues as well as other people, so maybe they are being recognized by others or not recognized by others as being a science person, but regardless of those cues, they're not picking up on it. What's really driving their identity in science is that they love it. They're really interested in it, and they're really captured by the ideas in it. I think it's a little bit narrow to really frame it around just the social performance aspect, and we really look at the social performance together with that internalization process. They have to internalize that "this is how I see myself." There are many factors that lend to "this is how I see myself."

How are you currently measuring identity?

This is another contentious point. I've had many conversations with identity theorists around this point, and usually I can bring them around to seeing my view with lots of hypothetical examples from interviews we've done with students, et cetera.

At the moment, the way in which we measure identity, we take into account three constructs: their recognition by others and themselves, [i.e.] how they see themselves, and how they're seen by others. Also, their interest and their performance competence beliefs; do they feel capable of doing physics, and do they feel capable of understanding physics? I'm talking about physics identity because I live in that space.

However, my caveat is that this is not crosscutting for all people at all times. This is for students in a heterogeneous environment, physics environment. It's for students who are taking an introductory physics course who are just learning about physics, and the students

are very different from each other. Some of them might be bio people, some of them might feel like they're math people, some of them might feel like "I'm not a science person at all, I'm just taking this class." They're very different from each other, and there's no sense of a physics community or a science community necessarily.

We're developing measures for students who, once they enter the physics major or a particular disciplinary major, start to identify and build their identities in different ways. One of the new parts that we're including in our measure for identity is sense of belonging. We see in our structural equation models and other modeling that this sense of belonging is becoming important because now they have a community of practice. Now they have a bunch of other students who are as interested as they are in physics or in biology or whatever disciplines you're talking about. Their sense of belonging with those other students turns on as an important construct to their self-recognition as a physics person. Whereas before, when they were in the introductory course with biologists, or when they're hanging out with their friends who are not physics majors, that sense of belonging measure is not important, but the interest and the recognition still are, and the performance competence beliefs still are.

I think we don't see measuring identity as being "this is how you do it" all the time for all people. The answer is like all answers in education: it depends. How you measure identity depends on the context, it depends on the people around that particular student, the situation that they're in, what they're being asked to do in that situation. I think we don't take it as one-shot deal; it depends on the situation.

That sense of belonging; I think that's wonderful. Does that then become a part of the measure of identity? Or is it like a covariate that you see moving with identity?

Yes, I think the way in which we've conceptualized identity, we put it as part of the construct, so then it's a richer construct of how we measure it. Otherwise, the way other people have been measuring identity, they really just focus on that recognition. Identity becomes that recognition as "do others see me in this way?" This is, I think, very limiting to the construct because we know that the interest component is important for self-recognition. Our definition really has to do with that self-recognition, and because we say that self-recognition is dependent on these other latent constructs that in some ways are part of seeing yourself in that way. The interest piece and the recognition by others piece, that performance competence piece, that sense of belonging piece—those are part of it but not all of them are part of it all the time. That's the complicating feature. If you're in a heterogeneous environment, if you're the only person interested in physics in a group of students, then maybe that interest component is more important in that space than in a space where you're with a bunch of physics majors and they all love physics and care and are interested about physics. Then it's not differentiating you as being more that kind of person, do you see what I mean?

I think this is part of the reason why in [Heidi Carlone and Angela Johnson's](#) work from 2007, they didn't have that interest piece. They only had the recognition, the performance, and the competence piece because they were studying women scientists who all had an interest in science. It didn't emerge as something that differentiated these women's identities. They were already all on that page, but when you look at students and you look at young kids as they're developing their identities, that interest is fundamental to them really starting to feel

like this is for them, and this is how they see themselves. For other students, when we get up to the cohorts of biology majors or physics majors or engineering majors or computer science majors, their sense of belonging with their cohort becomes important much more so than it was developmentally, early on.

Is it possible to create tools to measure identity that practitioners or evaluators could easily use?

Yes, and we are doing that. We're doing that for high school physics teachers. We already have an instrument, and we are sharing it with high school physics teachers so they can assess whether they see development in the course of the school year over time amongst their students. We're developing all kinds of interventions for high school physics teachers to use.

We have a new \$3 million [National Science Foundation grant](#) to do this and to really start getting high school physics teachers to implement certain activities, implement certain interventions, and take certain approaches throughout the year that help students see themselves as physics people and then maybe assess whether it's working or not.

In regards to that grant, are the teachers themselves administering and making sense of those results?

We're in the very initial stages. We have the instrument, and we have a very loose set of guidelines, but we're in the process of developing an analysis protocol for them. We're developing ways in which they can enter the data where it will be analyzed for them. There are systems that are out there that teachers can go in and enter their data on any particular instrument. For example, [the force concept inventory of the Thornton-Sokoloff force and motion conceptual evaluation \(FMCE\)](#) will analyze the data for them, and it will give them some nice graphical outcomes for their students. We're in the process of thinking of doing something like that.

Right now we use very loose guidelines explaining to them the components of the instrument, like the constructs that are included and how they might look at changes over time for those constructs in the instrument. Right now it's very broad, not as specific as we'd like it to be, but I think we're working towards exactly that where we have an easy tool for them to use, they can enter the data, and they can see the results right away.

How do you think about other identities, such as gender, race, and socioeconomic status, and how those might interact or overlap with science identities?

I work in the gender space a lot. We know that gender is another social performance. It's another way in which students identify themselves and can be identified by others based on how they perform their gender. We have ideas about "what does it mean to be female" or "what does it mean to do female." Like to perform being a female or to perform being a male, to perform being transgender or to perform whatever it is or however it is that you identify and how other people identify you based on that social performance.

We think a lot about the intersection between the performances that are recognized for having a physics identity and the performances that are recognized for being a woman and how those things are congruent and incongruent. Even though we do take a more holistic

viewpoint, recognition by others is so fundamental to identity development. If there are certain ways in which you exhibit being a woman and those practices are incongruent with the ways in which you perform being a physics person, your physics identity, then there's going to be a fundamental identity disruption. You live in a disrupted state where you always feel like you just are not a coherent person because you have two combatting identities. It's like, "Oh, I'm going to go into a room full of physicists now, let me put on my physicist hat and act in a different way than if I'm going to go into a room full of my girlfriends or my friends and act in a completely different way." You put on these different hats every time and different social performances, and it can be very disruptive to yourself if you're not fluid in every space.

Really thinking about all those ways in which physics identities and how people develop and are recognized for having a physics identity can be incongruent with how they're recognized for being women and being feminine and those kinds of things. We really thought a lot about that, and some people in our group are really thinking about the race dimensions too.

I'm at a Hispanic-serving or a minority-serving institution where the dominant population is a minority on our campus. We're only 12 percent Caucasian or white, and we're 60-something percent Hispanic and about 14 percent black on our campus, so we have a huge amount of diversity. We really think a lot about how race and ethnicity plays into identity development, and the intersection of all these things plays into identity development. But right now we've worked most on gender.

There are a lot of people that are talking about things like interest, motivation, and attitudes as outcomes for science learning. How do you think these connect with identity, and how do you distinguish science identity from these other concepts?

As I mentioned before, interest is part of our holistic conceptualization of identity. It is part of how somebody starts to see themselves. I'm going to stick with the idea of physics because it's disciplinary identity. We like specificity, and maybe it's because my background is in physics, I like things to be very clearly defined.

We think about physics interest as part of the development of physics identity. I think maybe we're nuanced in this way because we're studying physics. So many of the students who end up becoming interested in physics, it's not because they're recognized in that space because there are so few people around them in K-12 who are really interested in physics or doing physics. Even their teachers are not particularly that engaged in physics compared to life science. And definitely in elementary schools there's more of an emphasis on life science than physical science and there's more of a fear of physical science than of life science. I think for a lot of these students, so much of how they see themselves is driven by what they see on television—by ideas and concepts that are captured, that capture their imagination and their interest, and because we see that interest is so fundamental to the development of an identity in the physics space. As they start to be in a physics classroom, then that recognition starts to play in, and also those performance competence beliefs that "I can do it" and "I'm good at this," et cetera, play into it as well.

In terms of motivation, it is a broad umbrella for a lot of things. Motivation is the drive to action. And so I guess the way in which our conceptualization of identity of motivation is that if you start to build an identity or develop an identity in the space, it will drive you to persist, or it will drive you to choose the next class, or it'll drive you to even think harder about it when you're engaging in learning in a classroom or outside a classroom. They'll engage you to pick it up and read a book that you wouldn't have normally picked up and read. If you see yourself as a physics person, you will pick up that book and read it if it's not required, so it will drive you to action. It will motivate you to action. In that sense, it's related.

Do you have some examples of resources or tools for measuring understanding identity that you found useful? Are there some people or projects that you would recommend?

For the high school physics teachers that we work with we basically put together an instrument and it includes items that capture the constructive interest, and performance competence belief. Belief in their ability to perform the task the teachers are asking them to do and belief in their ability to understand physics as well as recognition. How much they feel recognized by the other students in the class, the teacher themselves, and by people outside the class, in terms of being a physics person. Finally, the last part is that self-recognition: do they actually see themselves as a physics person?

Those are the constructs that we use when we're trying to measure identity, and they've proven to be really highly predictive of student's choices. That's really what has sold us that these measures are on average very stable, reliable, and valid. We've used them over and over again over half a decade now. They've consistently proven on discriminant analysis on them, and all kinds of different analysis on them, so they've been pretty stable and well-functioning items.

Are those available for evaluators or teachers to use?

Yes. Currently we're making them available to high school physics teachers but not in a broader context. We're getting ready to put out a paper in the [CBE—Life Sciences Education](#) journal on biology identity, which is really taking the same idea. It's taking that same conceptualization and the same constructs in measuring it for biology. So that one hopefully should come up in *CBE*. I'll be perfectly honest; I've never been in the game of instrument development. When I come around to publishing papers, I don't normally write instrument papers. I will write a paper where we've developed an instrument, validated it, and found it to be reliable, and then actually look at a more interesting question like "how does something that a teacher does affect identity development?" So I've used it more as a tool than publicized that tool for access to others, but we're starting to do that. We have the one in bio and the physics identity survey that we are now disseminating to teachers.

Have people asked you about the possibility of transitioning the tools to new STEM disciplines beyond physics or biology?

Actually a lot of that has happened. Some of our former graduate students have taken it and expanded the framework and used it in engineering. They're already doing it in engineering. I don't think they've written instrument development papers though. I think they've used it as a tool to create the instrument, validate it, and make sure it's reliable, and then use it as part of a research study to answer a different question. So it has been done in engineering. I have a former grad student in math who's done it in math and has a paper in child development, but again it's not an instrument development paper. That particular paper is a structural equation model paper that's looking at the theoretical conceptual framework and trying to understand it using STEM. I think that we're doing it, it's just we are not publicizing the instrument.

Our questions are very broad, but that's also a caveat for our questions. I'm very pragmatic. I will criticize my own work, so the measure is I think a good one if you want to get a broad sense of somebody's identity that's pretty stable.

When we look at math identity, and we've done this with our math identity instrument over time, if we resurvey people their responses are pretty stable over years. We followed up with the same group of a hundred students a few years later, and their responses to the math identity questions were pretty stable. We're measuring a very macro level of identity. People who don't see themselves as math people. Four years later in college they still don't see themselves as math people. While this is sad, and I don't think it necessarily means that they will stay that way, it just means that they're not accumulating enough new experiences to change that view of themselves.

I'm not sure whether this particular instrument would be able to detect small changes in identity. I think it would detect broad changes in identity. If there's a big change in how somebody sees themselves because they've accumulated a bunch of really good experiences over the course of the year or couple of years, then I think it has potential. But I think if you're looking at one intervention or looking at like very micro-level identity fluctuations, then it'll be hard to detect with this instrument.

Is there anything else that you want to share?

I think maybe I'll just reiterate it's not a one-shot deal. It's not like this is the only way it can be conceptualized for all time. This is the way it is for all humans all of the time in every context. In all complex measures or complex ideas related to human beings, it is nuanced to the context and the situation and the number of experiences that person has had with respect to that discipline, in this case, science.

I think all of those things matter, and how we try to get at it, because if somebody has accumulated a lot of experiences with respect to science, shifting that person's identity in science is going to be very different than somebody for whom it's one of their first experiences with science. I think this also lends to the fact why early childhood experiences are so important because they're very informative. They are the things that seal that initial identity development that this is for me—"Is this how I see myself with respect to the world?" Then that person can carry on that identity and build upon it, or are those experiences things

that start to make people say things like “I’m not a math person,” or “this is not for me,” or “this is not how I see myself.” In which case, it’s much harder to accumulate enough experiences to change that, and I think this is where the informal science world is really important because those early developmental years can actually have a great impact. The only problem is how do we reach enough students through it?

Informal science normally reaches the students who have other resources like parents, family environments, and a school system that are supportive and encouraging. How do we get those sort of informal experiences in the early developmental years to students who don’t have all those other resources, who wouldn’t have those opportunities to engage in science and to really start to see themselves as science people? How do we get it to those particular kids?

What is STEM Identity? An Interview with Jennifer Adams

On November 2, 2017, [Jamie Bell](#), Project Director and Principal Investigator of the Center for Advancement of Informal Science Education (CAISE), interviewed [Jennifer Adams](#) to understand her thinking and work on the topic of STEM identity. Dr. Adams is an Associate Professor at the University of Calgary. Dr. Bell conducted the interview on behalf of the CAISE task force on evaluation and measurement.

A video of Dr. Adams's interview, as well as interviews of other researchers, is available at InformalScience.org/identity.



Can you tell us about any projects that you have worked on or are working on that involve identity as a component?

I've done a lot of projects on identity. [Preeti Gupta](#) and I looked at youth identity in informal science learning spaces, and we wrote a little bit more about young women's identities and STEM through their relationship with informal science learning. Then I did some work around place identity and sense of place. My most recent work is focusing on STEM teachers, science teachers, and their identity in relation to informal science learning. I started out with looking at informal science learning experiences and how that shapes their identities as teachers. Most of my research has either identity as very central or peripheral to it.

In that work, do you start off from a common definition of identity or is the definition you use contextual?

It's very contextual. It's shifted even from the time that I started looking at identity until now. I think the thing that has maintained at the core though is the notion of identity, agency, and learning and how those are all related to each other. As a person may learn in a given context, they develop a particular sense of agency in there. That therefore contributes to their identity, being like either themselves or being seen as others as a particular type of person.

In the [research that I'm doing now](#), I'm looking at the agency that has been central for a group of teachers and how they're both defining and redefining informal science education in their classrooms and how this is dependent both on their own social identities and what they're bringing into the teaching and learning context but then also in relation to the identities of their students.

It's very complex, and I think it's becoming more complex as I learn more and research about it. I also find, even though I don't use this term in my work, the notion of doing identity work. I don't know if you remember that article by [Jay Rounds](#) a long time ago about doing identity work in museums? It's a blast from the past.

Because of this interview, I revisited that piece. It really does ascribe this notion of identity as being an ongoing process that is something that you're doing either through positioning or through being identified. It resonates with [Anna Stetsenko](#), who I've been using a lot in my work recently because she has this transformative activist stance in relation to identity. She talks about being and becoming, and so it's this ongoing process of being and becoming and positioning yourselves with others learning how to contribute to a given community. All of these different notions of identities have really resonated with me. I'm definitely not seeing it as this fixed thing or something that you finally reached this particular identity, because it's always going to be this process.

How do you see the relationship between agency and identity?

First there's learning. As you learn, and whether that is through formal or informal means, as you learn to become a part of a community, you develop a sense of agency in being able to contribute to that community and that becomes your identity.

As a beginning flamenco dancer you don't really consider yourself as such because you don't know a lot of the terms and a lot of the particular background or baseline things. As you learn, you're able to contribute through choreography, through performances and everything so you come to identify as a dancer, as a flamenco dancer. It's the same thing I think in any endeavor that people pursue. As they learn, they develop agency, being able to make changes and to shape things in that field and through that they learn to identify in that field.

That identity in the field is not a monolithic identity. It's not like "a" flamenco dancer, or "a" science teacher, "a" scientist because they're still going to be multiple facets of that identity or that label. There are still going to be multiple facets because of all of the other social identities that the person is bringing into that setting.

In terms of other people's work, are there distinct ways that you're looking at you would say are different from how other people are looking at it?

I think my work is heavily intersectional, and it really does not focus solely on the science learning aspect, but it really looks at how the other identities intersect with that aspect of science learning. I even see it in the work that I'm doing now with my science teachers because there's a bunch of them, and they all have different identities. Three of them that I've looked at in a group are women of color, and they all teach in very different schools. How they approach their science teaching and think about themselves vis-à-vis their students

has to do a lot with how they view themselves as women of color in the science field. That's different amongst all three of them and in how they view themselves vis-à-vis their students.

A lot of them have taken up this notion of race and science in both implicit and explicit ways. Looking at [Nasir's](#) work around racial storylines, how they present because it's science. There are these notions of who can contribute to science, who can participate in science in the ways that different people should and could participate in science. These teachers are actively doing different things to try and debunk those notions of racial storylines so that their students can imagine different futures.

For example, one of the women is in a charter school that is very restrictive because it's focused on the standardized tests. She realized that all of her students were not coming with the same background as the students she student taught in an affluent, more white school. So she developed this whole after-school program in a library in the neighborhood so that the younger students and even the older high school students can come and learn science in these ways so that when they do get into the classroom, they have the science foundation. That was her motivation, out of her own pocket, her own time. These stories have been emerging from my data. A lot of it has to do with the notions of what teachers know about these stories of race and science and how it presents in their classroom, and what are they trying to do to make it different for their students.

You described a little bit about how you conceptualize and how [there are] distinctions and also the relationship to the other aspects of learning. How are you actually measuring it? Or what kind of methodologies are you using?

I guess it would be more of a grounded theory because I'm looking to see how it emerges in my data. A lot of the data that I collect is very narrative. We have ongoing meetings with the teachers. I have one-on-one dialogues with them. I've gone with them on their field trips and not necessarily as a participant observer but just along with them. Just observing them and their students and how they interact with their students and how their students interact in these different spaces that we bring them into. I've used discourse analysis and narrative analysis to really see how they talk about themselves, how they talk about their students. What are the other aspects that they're bringing into these conversations, what motivates them to do what they do?

It's very emergent because I think it would be very hard to structure it into one tool that's going to measure an identity, and especially if we're talking about science identities, because there is still a pervasive notion of one way of being in science and one way of doing science. The hegemonic notion of science, and I think that if we start to think about measuring science identities, it's going to lend itself more towards that hegemonic notion of science. It's going to exclude a lot of people because they're not going to fit those measures.

We heard from others that they've struggled or even given up on developing scales or measures for identity as a distinct construct, although some people are using some tools they've developed.

I'd be interested to see what those tools look like.

Do you want to say anything more about other identities besides STEM or science identities—gender, ethnic, any other social aspects. You take a broad intersectional view of everything. What's the relationship between them and science identity?

They definitely influence science identities, and I don't even know if there is a science identity. I would say there are multiple science identities if there is such. I mentioned before there are stories that exist about race and gender, socioeconomic class, that influence what people's perceptions are and the opportunities that they have to engage in science. For example, if I'm a woman of color, I'm going to have a lot more barriers to engage in science than a white male, and so that's going to influence a type of identity or how I identify ultimately with science. All these things intersect. If you think about socioeconomic status, that's going to be "oh, poor people can't do science" or if you're in a poor school you don't have access to the resources that allow you to identify with science in a way that is commensurate with your own existing identities. That's the thing I feel about science too is that we talk about science identity a lot. Stuff that I read is that people have to fit into a science identity, but science needs to be more expansive and inclusive in order to accommodate different identities. There was an article that Megan Bang and Carol Lee and Doug Medin wrote a while ago for the [Scientific American](#), and they touched on how we know women. They were able to approach a particular research problem, I don't remember exactly what it was, from a different perspective just for having lived experiences as females. It was climatology or something, and so that made me think about all of these different perspectives that they have from their own lived experiences coming up against this notion of science that is supposed to be objective and universal. It's through these different lived experiences that enable us to approach scientific-related problems from different ways, especially now when we think about all these really complicated scientific problems like climate change. It is a big thing. I'm going to approach it very differently from somebody living in an urban environment than somebody who's living on an island. Even somebody on an island with more resources is going to approach it differently than somebody with less resource.

It's about expanding science to accommodate a broader range of identities rather than having a funnel where everybody has to fit into this one or even a small scale of science identities.

That makes sense, and your work really bears that out in terms of people's lived experiences.

So how do you think about interest or motivation in identity? When I was a high school student, the narrative I tell myself for the reason I didn't get interested in physics in high school was that I thought I couldn't be interested in something that my physics teacher, who I did not identify with, was interested in. I looked at it closely and thought if being interested in that means I'm that kind of person, I know I'm not that kind of person. My interest wasn't sparked or even my curiosity around that.

That example that you gave is perfect. It's different for different people, but I do think that the interest and motivations that people have are going to be somehow related to their identity. It is about a positioning and how you want others to see you. Preeti Gupta and I were talking about this with the science café in trying to theorize that people maybe attend science cafés because they want to be seen as smart or they want to be seen as a part of the group. Science still has this perception as being an elite pursuit, an elite subject. They want to identify with that so that would be their motivation for maybe attending a science café, even if they're not interested necessarily in the topic.

It is about whom you want to be seen as. It's about who you aspire to be and that has to do with motivation. In your case you saw this teacher, and he was not somebody that you wanted to be like, and you strongly associated with him with physics. Had you had different experiences with physics, maybe you would not have had that strong association with that one person and physics. It's complicated, but it's that motivation piece. I do think it's important because that's about the whole piece of positioning and how they say the scene; you go to a scene to be seen, and being seen as doing this type of activity. Because people see me performing this activity, they're going to ascribe me with this particular identity or characteristic.

You've already mentioned a few sources that have been important to you; Stetsenko, Jay Rounds, the Medin, Bang and Lee piece. Are there any other resources or papers or anything you would point people towards if they want to understand how identity's being thought of in theory and in practice?

I would talk about the [Nasir and Shah](#) talk about racial storylines and again going back to Anna Stetsenko's work on transformative activist stance. I think that a paper that Preeti Gupta and I wrote in 2015 in the [Journal of Research in Science Teaching](#) really ties agency identity and subjectivity nicely together, and that's allowed me to really tie that notion of learning to teach as having agency and shaping and enabling particular types of learning experiences for students.

Those are the ones that I tend to revisit because I know that in that paper we built a lot on Anna Stetsenko's work. And [Jay Rounds](#), this interview made me think about that, and when I read it again I had a newer understanding of it because I know more now.

If somebody was developing a project right now and there's an NSF AISL deadline next week, and they were thinking about identity as something that they're setting their project, design, or intervention their addressing; do you have any other thoughts about what they should think about, how they should think about it, measuring it, or any advice you would give people?

The measuring is the tough part because it's such an intersectional piece. For proposal purposes for readers, you do have to make it as linear as possible, so I would encourage people to maybe think about and to diagram out the constructs that they think contribute to identity in that given context. And what the outcomes are that they would want to see of people in relation to science, and maybe not labeling it as a science identity, but thinking about it as multiple science identities. What are the different ways that people engage in science? What are the agentic ways that people engage in science?

Wow, I never heard that word before.

Well, yeah, it's coming from Anna Stetsenko again.

A lot of people like to tie identity and equity but not really necessarily thinking about science as a field itself. I know that's a bigger ask to think about how we can go about changing science so that it accommodates a broader range of perspectives because a lot of equity seems to point to having students fit into a particular science box rather than expanding the box or getting rid of the box—I don't know.

I would say begin with what you think contributes to identity. Even thinking about the kinds of identities going to that notion of agency. What kinds of agency would these identities afford the people, the participants in the program? What will they be able to do as a result of that would be transformative for them? Will they be able to access higher education? Will they be able to ask questions or address questions about their own healthcare? Will they be able to respond saliently if they had a community board, and they were discussing something like climate resilience or talking about cleaning up like a Superfund site? Would they be able to contribute in a way that would make decisions for the betterment of their communities?

Think about the larger contributions that people will make beyond just that project. What kinds of knowledge, sustaining identities, will they develop that will allow them to contribute to society in a way that allows them to be knowledgeable about science? Even if they're not going to be scientists but want to be knowledgeable and be able to talk saliently. To be able to access and appropriate science resources in order to improve their lives and the lives of their community? I'm thinking in that more social justice oriented way—the larger social justice for the collective. How is the individual going to contribute to the collective?

What is STEM Identity? An Interview with Kevin Binning

On October 10, 2017, [Kevin Crowley](#), Professor of Learning Sciences and Policy at the University of Pittsburgh, interviewed [Kevin Binning](#) to understand his thinking and work on the topic of STEM identity. Dr. Binning is an Assistant Professor of Psychology at the University of Pittsburgh. Dr. Crowley conducted the interview as a member of the Center for Advancement of Informal Science Education (CAISE) task force on evaluation and measurement and co-Principal Investigator of CAISE.

A video of Dr. Binning's interview, as well as interviews of other researchers, is available at InformalScience.org/identity.



Tell us some of the projects that you've done that focus on identity.

Identity plays a role in most of the work I do. And this includes identity broadly construed: racial identity, gender identity, my identity as a first generation student, as well as things like science identity, or math identity, more domain-specific types of identity. Primarily my work that's focused on these has examined the role of identity in an educational context. So the fact of me having a particular identity; how does that change the way that I engage or that I feel that I am motivated to succeed in these various domains? Being a first generation college student, for example, can affect the way that I engage in college or the way that I cope with setbacks or the way that I adjust in the face of adversity. As can things like having a science identity will change the way my motivation to engage and to excel in a science field. And also the extent to which my self is on the line when I'm doing science. That's the way that I would view identity. So if I have a very strong science identity, my self becomes very relevant to the task at hand, the scientific task that I am currently engaging at that point. That will vary relative to someone who doesn't have a science identity. Maybe they don't care as much, they're not as engaged, they're not as focused, their self isn't tied up with whether they succeed or fail in that domain. That would be the way I use identity in my work. I could go into more specific examples.

Across those projects, how do you define identity? Is there a specific kind of identity or specific definition? You're a social psychologist, correct?

Yes. In social psychology we do a lot of work around identity, and a lot of this comes from a theory from social identity theory, which is this basic idea that we all have multiple different identities. So I'm a father, I'm a college professor, I'm a scientist, I am somebody who likes statistics and psychology, and all of these we can construe as different identities that will become kind of active or salient depending on the situation that I'm in. So when I'm at home with my children my identity as a father is very salient. When I am doing scientific tasks my identity as a scientist becomes very salient. So it's basically these are multiple ways of defining the self. And the self can shift in the way that we define it depending on the situation at hand. So it's almost like we all have multiple identities and each of those identities gets called out in a particular context. And so literally the way that we think of it is that you are that identity in that moment when it's being called out. When you're doing a science task and your science identity becomes relevant that's how you're thinking about yourself. You're not at that point thinking about yourself as a father or as a fan of a particular sports team or what have you. But when you are watching a sports game then your identity as a Steelers fan becomes the dominant mode, and you'll interpret information differently depending on which identity becomes salient at that time. So it's actually the different modes of defining the self that gets called out by different situations.

You talked a little bit about having a science identity in a science learning context, but talk a little bit more about specifically why and in what ways identity matters for science learning.

If I have a part of myself that I view as a scientific person, as somebody who excels and succeeds in science, and that it's important for me to do so, that's how I would view, or label somebody as having a strong science identity. When I'm doing a science task, if I'm sitting in the biology classroom, and we're taking a test in a scientific field, chemistry test or what have you, I have more at stake for me in that situation than somebody that is not identified with that domain. Let's say I don't have a strong science identity, I might still want to do well. But if I don't do well this is not relevant to me as an individual, to my core being, that I didn't do well in this particular task, I can do other things. But if I have a science identity, I really want to do well at this task, the stakes are higher. It's like I have more, a larger bet on the table, if you will, if I have a strong science identity relative to if I don't. In that sense it's a very important construct and what we found in our research is a combination of different things that can make you feel more anxious in a lot of ways. That is, you'll be more concerned about doing well and that can be a double-edged sword. On the one hand it can make you want to study more. On the other hand it can make you afraid about choking. I really want to do well in this domain, this is very important to who I am and that makes me more anxious. So it can go either way. There's more on the line. The stakes are higher, in a sense I might be more apt to study hard and put all my heart and soul into this, but on the other hand I might be more cautious and more circumspect and want to withhold for fear of failing. My fear of failing in science is much stronger if I have a strong science identity, as is

my desire to succeed. So both of these kinds of element become stronger if I have a strong science identity relative to somebody who doesn't. Sure I can succeed, or I could fail, not a big deal. But if I have a science identity both of those are very important. And they can tug and pull at each other. I might be so worried about failing that I self-handicap. Or I'll do things that are not conducive to success. So I'll stay up late partying the night before the exam or I won't focus as much as maybe I should because I have this doubt about myself that if I don't do well here this is an indictment on me personally, and it's a part of myself that I view as very critical. Part of what my work actually focuses on is how we channel science identity and things of this nature to get the positive outcomes. That is, don't be afraid of failing, you need to go out and study and do the things that you need to approach to be successful.

Could you give some examples of some of the interventions that you do?

We have a great dataset right now where we did this at the college level with Pitt students. At the beginning of the year we asked them, "Do you think of yourself as a science person?" "How important is it for you to do well at science?" So this gets at the idea of how do you measure identity. So we measured it with just a self-report—I think four items on a Likert type scale (1 to 7). And then we looked at how students that were either high or low in identity responded to the intervention that we did. The intervention is literally building up the last comments I made where what we're trying to do is teach students how to play defense in a smart way so that they don't go down a path where they feel like they're a failure or that they're not meant to belong or they can't succeed in science. So what we want to happen and what the intervention is designed to do, which I'll explain in a second, is when students face adversity—when they get a worse grade than they expected, when they hear from a professor that they got the wrong answer when they raised their hand in class—ranging from relatively minor setbacks to relatively major ones like not doing well on an exam, they don't interpret these setbacks as an indictment on their person. What we try to do is train them to view these setbacks as a normal part of being a college student and is surmountable with effort and persistence. At the beginning of the year, roughly around the time where we collect these measures of science identity, we will present a lesson on what we call a social belonging lesson in class. This is led by the instructor and in college and is a recitation course section consisting of multiple parts. They'll do a reflective writing task to bring up examples of adversity that they've experienced coming to college and importantly how those have improved. We then give them examples of other students who struggle. But these struggles have a very specific narrative, and it's this generic narrative of "I started off struggling, I made some adjustments, and now things have improved." We want to try to inculcate this mindset in the students so that when I'm struggling, this is part of the journey that I can be in control of, and I'm not unusual for struggling. Keeping in mind that people with high science identity will find the stakes are higher for them. So they're more volatile in some sense, when I get bad feedback, when I get a bad grade and it's on an exam and I'm a science person that's a big hit, right? And that can lead these students down paths where they're making attributions, and they're understanding their experience in a way that is not conducive to maintaining engagement.

They're saying things like, "oh this may be evidence that I don't actually belong here. I thought I was a science person, but actually now maybe I'm having second thoughts about that, and maybe I should focus my energy somewhere else. Now I'm not going to study as hard on this exam. I'm going to study for this other thing or maybe I'll focus more on my friendships or what have you and neglect this kind of part of myself."

The intervention is through these things so that they do this writing exam, this writing task. We give them examples, and then we have them break up in small groups, and we give them discussion questions to try to understand that other students that they're literally sitting and talking with have similar fears, have similar struggles. This is not an indictment on you that you don't belong. This is because college can be really hard and challenging, and the study strategies that you came with might not be the best ones, but that doesn't mean you can't change. And that doesn't mean that you can't make progress and you can't grow. The path of growth is especially important to bring online when I'm struggling, when I'm facing adversity, when I'm not doing as well as I thought I might. We do this lesson at the beginning of the year, and then we track students over time in the class. What we find is that overall, students who got this—and we do this experimentally, so half the students get this lesson and half just get nothing like business as usual in their classroom—what we find is that the students who get this intervention and are trained how to think about adversity in this particular way, do better overall. But even more importantly, students with a high science identity especially benefit from this intervention. So this is part of getting this idea of the stakes are higher for these students, and so it's more important for these students to get this intervention. The students with high science identity that didn't get the intervention actually tended not to do very well in the course, especially if they were from an underrepresented group. So this brings up ideas of intersectionality that I think we'll touch on more.

It also gets fairly complicated. Now we're talking like a three-way interaction, which is hard to wrap your head around especially without my PowerPoint here. The bottom line is that the intervention is geared towards helping students in general. But in particular, for helping students that have a lot at stake. That includes students that have a very strong science identity. It teaches them to view setbacks not as an indictment on themselves but as part of a normal process of growth that can be improved over time.

So there's a lot of different ways that people approach identity. How is your approach distinct from other approaches?

I think there are multiple ways to think about identity and the way that social psychologists, although not exclusively think about it, is something that can be quantified through self-report. There are, of course, limitations to this, and there's no question about that. What we ended up trying to do is put a number on how you think about yourself in terms of this continuum of being; so 1 is "I'm not a science at person" to 7 "science is the most important part of my identity." Most people fall somewhere in that range but in that continuum. And then we try to make predictions about if you say you're high on this dimension you'll engage in material in a particular way, and if you're low on this dimension you'll engage it in a different way. It's very quantitative, and we basically just self-report.

What are the questions specifically that you ask people?

One example of a question is something like, “I tend to think of myself as a science person.” In addition to a question like “other people tend to think of me as a science person.” 1 disagree, 7 strongly agree.

And so it’s both my own estimation of how important science is to me and also this meta perception of how much I think other people think that it’s important to me. It’s almost a looking glass, so part of how I view myself is dependent on how I think other people view me. The measure tries to capture both these kinds of dimensions or ways of thinking about a science identity. It’s also nice from the self-report aspect. We think that the self-report perhaps what the social desirability of things of this nature will be; I could have a science identity that nobody knows about. Or I might not necessarily view myself as a science oriented person, but I think other people do. This measure choice would negotiate these differences and put a single score on the extent to which I view myself as having a strong science identity.

How is that different than ways other people might approach identity?

Even within social psychology there are other ways to do this. Something like an implicit identity would be one way that I could imagine measuring in. This would be things like a reaction time test where you could flash a word up, a series of different words, some of which are related to science, some of which are irrelevant or have other traits, and how quickly do people say me or not me? Does this word describe me? Does this word not describe me? The idea is that your reaction time will be quicker for words that describe you than words that don’t. Essentially it’s an implicit way of when I see things in the environment. How much do I view them as relevant to me versus not relevant to me? This obviously is a little bit more onerous to collect, especially in a large college classroom because you need a computer, and you need students to be sitting captive, and you need multiple trials of this to get a reliable estimate of an implicit measure. The implicit measures don’t always perfectly correlate of course with the explicit measures of science identity. But they are correlated, positively correlated as you would expect. Usually somewhere around 0.3 or something like that—so moderately correlated. But they’re not the same. They are different constructs. I think other ways of capturing to the extent somebody has a science identity might be through interviewing, through qualitative reports of just asking people how important is science to you. You could also do things like observe engagement on a science task. So bring students into a room and have science related activities there and time how long they stay engaged. Maybe you have a science task here and a nonscience task over there, and they can choose to either engage in one or the other. You can get another number to quantify how long they spend on a science task versus the nonrelated science task and then infer, based on that, oh they must be really interested in science more so than this other topic. Of course that’s limited, everything has its limitations. There is really no perfect way because it’s this latent construct that we can’t actually see. We’re trying to get through various observations, self-report observations, reaction time trying to get a proxy for what latent idea of science identity might be. If I have two tasks here, I’m really interested in one not the other, that’s

limited in the sense that this alternate task might not be intrinsically interesting but there might be other things that are. Likewise, how do you pick the right science task to measure science identity? If I had my druthers of the best way to do this would be combining multiple of these and try to triangulate on this latent construct. If you have unlimited time and resources to measure these ideas and combining these different approaches you can answer this or put your finger closer to where this latent construct of science identity might be.

Is everyone in agreement what identity is or are there important theoretical differences that we should be aware of?

You know I think there are definitely theoretical differences. I think in social psychology what I just described would not be controversial about people; this would be, “how else would you think about identity?” This is the norm in social psychology. It’s this latent construct that can be activated by the social context and what shapes the way that people engage in that context depending on whether they are high in that identity or not. I am certain that there is disagreements and other ways of viewing identity, and honestly I’m less familiar with those others than my own bubble.

So we’ve been talking about science identity. Do you think there is a STEM identity and is it distinct from a science identity?

I can give you a good example, which touches on ideas of intersectionality. I would tend to view science identity as an umbrella construct, under which [there are] multiple [identities]. So you could have science identity, then you could have a biology identity, a chemistry identity, a physics identity, a math identity, engineering identity. Which are loosely, and I would argue, would probably be positively correlated with my science identity but also might have more domain-specific predictions. A really general generic science identity construct is useful potentially across all of these domains because it touches on all of them a little bit. But if I was really interested in let’s say math identity, I would probably want to measure science identity, but I then also [would want] one [measure] that’s more targeted towards math. The reason is each of these disciplines is incredibly rich, and it takes a lot to get involved with it. There’s a great example of a classic study in social psychology by [Steve Spencer and Claude Steele](#) and colleagues where they went into a testing environment, the math subject GRE. It’s not the math portion of the GRE, this is people who want to go into math graduate programs; they have to take the math, so it’s much harder than just the regular math portion of the GRE. They got men and women who were interested in pursuing graduate careers in math to come in and do practice problems and get a score. They made it such that the score would be an indicator of how likely you are to do on the actual math subject GRE. If I didn’t have a strong math identity, I probably wouldn’t be taking this test. This wouldn’t be something that I’m interested in pursuing. But I am interested in this, and so let’s say I’m also a woman taking this test. Now I know that women are negatively stereotyped in the math field, and the stereotypes in the math domain are probably different than the stereotypes in say a field like biology. Math has a very male-dominated history where

I think even the Stanford Math Department, for example, didn't even have bathrooms for women on all the floors of their building. So I think, and Claude Steel talks about this, that women used to have to go down to the basement to use the restroom if they were in the math department at Stanford. So just an example of kind of the institutional normative-ness of being a male in math. That in itself is a more specific type of math identity that would have different implications for women that the science identity might have difficulty picking up. Math, physics, and engineering, these math-oriented domains might be more specialized in terms of the types of identities that are at play. It depends on the way social psychologists would think about this. You're in a math setting, yes, your math identity would be relevant, but potentially also your STEM identity getting brought in, maybe even also your science identity. But those would be more diffuse than potentially this science identity or this math identity activated because it's so math focused. Science identity would be maybe useful across the different disciplines of science that students might engage in high school or college.

There's a question here about how easy it is, or how bullet-proof those measurements are. For instance, if you have two questions that you use to measure identity, could any practitioner use them and get a reliable measure?

I think so. That's one of the nice parts of that measure, given that no measure is perfect. One of the nice aspects of just the kind of self-report questionnaire is that they're very easy to administer, and I think that's part of their popularity. We do a lot of work in the classroom; we don't have time to bring in a whole bunch of equipment and video cameras and things that we might think could get a more precise measurement with. Instead we take this questionnaire that is very easy to administer. I think we used four questions or so and it would be very easy to scale these up and to distribute them to different practitioners who could then use them in their own classroom. And I think these are useful in that regard. They will give you information about who has the most on the line in science—psychologically and socially—for themselves and the way that they view themselves and the way they view other people viewing themselves. We think it's a rough but an adequate measure that is reliable as well.

You've mentioned a few times the notion of intersectionality. Tell us a little bit about how you think about how other identities, gender, race, socioeconomic status, etc., might overlap or intersect with science identity.

So the way that I would argue is that this idea that we've touched on already about the stakes being higher for folks with a high science identity can be multiplied by having another identity that also raises the stakes. Let's say I am a Latino American college student. I'm drastically underrepresented on campus. I know about cultural stereotypes, about people from my group that tend not to do well or there's gaps, college achievement gaps or just educational achievement gaps in general for people from that identity. But I would argue that actually makes science identity for those students even more relevant, and I actually think it is not just added, you have anxiety from being a Latino American and anxiety from being

science identity and you put those together. No, I think it's actually this Latino American makes science identity actually more important. It multiplies the factor, or the coefficient, that is assigned whether I have a science identity or not. And we actually have some evidence of this from interventions that I've talked about where students who have strong science identity benefited from this intervention that taught them how to think about adversity in a particular way. That effect was even stronger significantly with statistical interaction for minority students. What we think is going on is that on their own minority students are dealing with anxiety. On their own high science identity kids also have anxiety. If you bring those two together, now it's kind of double the effect, and I think even more so than just the sum of the parts, and it raises the stakes even more. Because now I'm doing science, but I'm also aware that there are negative stereotypes about my group in general but maybe especially about my group in science. Particular science domains are specific, like women in physics and engineering and math fields. That multiplicative factor might be even greater in those domains than in another science-related discipline like biology. That's not to say that there aren't negative stereotypes in biology as well, it's just that I think that they're even more salient or powerful in these domains where women are very historically and culturally understood to be not as high achieving as men. The way we think about it is that it ups the ante even more if you are from a member of a group that you're in science, but then there are also specific negative stereotypes about your group in science. The fact that I have a science identity and I'm from one of these groups means I've already negotiated some of these difficulties, I think of myself as science identity despite the fact that I'm a member of these underrepresented groups. But that then puts more weight on my shoulders because I am more of an island by virtue of having these, this intersection of these different identities.

A lot of people talk about stuff like interest, motivation, and attitudes as important outcomes for science education, science learning. How do these connect with identity or do you even distinguish those from identity?

Yes, I think we would. The way I would think about it is it's more like an independent variable that affects things like motivation and engagement. I think you could think of science identity as an outcome of a variety of processes. How do you build science identity? How do you make science identity stronger? Most of my work has viewed it on the other side of the equation, where it's a predictor. If science identity is a predictor, and it raises questions, where does it come from? We're not really struggling with those questions yet. You walk in, what's your science identity? Now we're going to make predictions about how you're going to be motivated and engaged in this domain. And so if you're very high in science identity, we think that your motivation and the implications of things like failure and success will be different for you than if you are low in science identity. It makes the science identity motivation mean a different thing. I'm going to be potentially more motivated to do really well in this domain that's central to my sense of self than a domain that's not central to my sense of self. I think that idea of viewing it as an independent variable rather than a dependent—and those are both very important in domains of study in terms of how do you build science identity. What my work is once you've got some level, some variation in science identity amongst the student body, is how does that affect motivation and engagement? We think it very clearly

does because my self becomes on the line when I'm doing science. What I would try to caution against is it's not that they're just automatically going to try harder. It's more complicated than that. It's more like they're on a knife's edge. That is, they could go harder, but they might also be more apt to disengage for fear of failure. For fear of making a negative indictment on myself by not doing as well as I thought I could or thought I should. And things like self-handicapping, which is like kind of self-sabotaging. Like purposely playing video games all night instead of studying so that when I don't do as well I have an excuse and say, "well, I didn't study as hard as I should have so that's not relevant to me or how smart I am, it's relevant to some choice that I made because of some other circumstance." That would be the one I think provides a little bit different way of thinking about it because it's not that science identity is just going to make you more motivated to do well all the time. It can do that, and we hope that it does, and that's what a lot of my work tries to do; to try to channel that so that it can be used and leveraged for good, for achievement and for success in science. We have seen that high science identity folks can also end up on the other end disengaging, dropping out of science, or just withdrawing from courses that are science related.

A lot of these information learning or science communication programs, particularly when it's youth with an eye towards college, are just all about identity and getting that identity established. There's a danger there and so would you go as far as to say maybe you shouldn't build such a strong identity because you put particular people at risk?

That's a great question. My gut instinct to that is we absolutely want to build science identity. I think what we just want to be cautious of is it's much better to have some science identity than no science identity. I think the kernel I would offer is just more that it's not going to be a cure all for getting students to do well in science. But once you have that science identity in place, the job doesn't end. There's still more that you need to be doing so that they engage in a way and that they understand setbacks that will maintain engagement in the long run. So without that in place, with no science identity, there's no hope. You're not going to be able to get that leverage. So it's better to have that. But I think what we need to be aware of is that it's not the end.

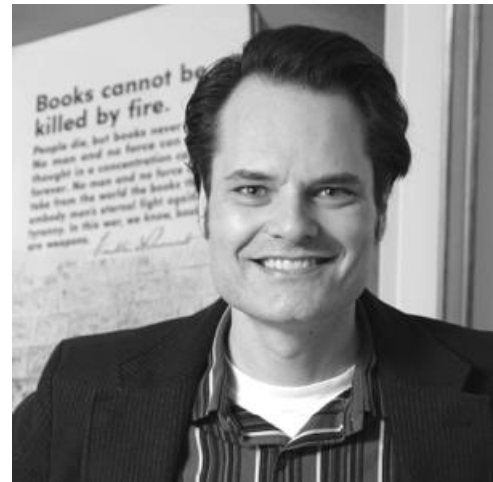
Well, someone's up on a precipice like they're up there. And they could go higher or they could fall off, and if you're responsible for putting them there, you have to recognize that and have systems that support them for what they need.

Absolutely. And that's much better. They're on the precipice, and so their fall would be steeper potentially. But they can also achieve. You now put them in a position to achieve higher. The stakes are higher. I absolutely endorse efforts to increase engagement and exposure to interest in science, but once you've got that science identity, once you've successfully done that, it's not that you're going to just all of a sudden be motivated and go off and become scientists.

What is STEM Identity? An Interview with Dan Kahan

On October 9, 2017, [John Besley](#), the Ellis N. Brandt Professor of Public Relations at Michigan State University, interviewed [Dan Kahan](#) to understand his thinking and work on the topic of STEM identity. Dr. Kahan is the Elizabeth K. Dollard Professor of Law and Professor of Psychology at Yale Law School. Dr. Besley conducted the interview as a member of the Center for Advancement of Informal Science Education (CAISE) task force on evaluation and measurement.

A video of Dr. Kahan's interview, as well as interviews of other researchers, is available at [InformalScience.org/identity](https://informalscience.org/identity).



Tell us how the projects you work on address the concept of identity in science.

There's a range of projects that my research group works on. Some are standard—I'll call them lab studies—and then others are field studies. And so the way in which identity plays in the research sort of depends what we're doing. We have a study recently, for example, on how people would form understandings of the best science for Zika and why it's here, what it can do, and what might be in the future, some of the things we need to take on in medicine to try to control its effects with vaccines. And there we used measures of people's cultural worldviews. These are scales of people employed to try to make sense of differences in risk perception and different reactions to science communication. And that's pretty uniform and standard. But like I said, we also do some field work, and there we have scales that are more fine grained and better tied to the project. So we do work, for example, [with science documentary producers](#). They want to know whether the product is something that's going to satisfy people who like science documentaries. So we've come up with measures of what people's science curiosity would be. They might be similar to the ones we do in the lab, but they're more fine grained and focused. Same thing with [advising public decision makers in places like Southeast Florida](#), [we] tailor them (i.e., not off the rack, but more tailored).

For the [Cultural Cognition](#) work, how does the cultural cognition measurement deal with the concept of what constitutes identity and how that fits?

I have a pretty broad understanding of what identity would be. And it's any kind of affinity group of which the members are connected, as often unconsciously as consciously, by their adherence to some sort of distinctive set of values that then will systematically shape the way that they assess information about science. If I don't know a lot about the group, then I'm probably going to start with the kinds of measures that I described at the beginning with the cultural cognition ones.

And what kind of questions does that include?

Well, it's really a 2-dimensional scheme. One of the dimensions is how individualistic or communitarian are you? Do you think that people should take care of themselves without assistance or interference from a collective, or do you believe it's part the job of the collective entity to secure the well-being of individual members and kind of roll over anybody who is in the way? And then there's another one, hierarchy egalitarianism—how do you respond to different kinds of authority? And those do a pretty good job. They're measuring dispositions that figure in risk perception for people generally. So if that's what we're doing, people generally will use those. Then the other ones tend to have more elements to them. They're taking more into account, more about where they live or what their ethnicity is, what the incomes might be and so forth.

Would somebody who is hierarchical versus egalitarian be more or less risk averse?

Neither, necessarily, because I think, although we're studying risk perception, one of the premises is that there isn't any abstract preference for risk. That these are very domain-specific kinds of outlooks. And even within them there might be differences that would defy any kind of an account of what's a risk preference. But if we look at, for example, the hierarchical and individualistic respondent, especially if one is a white male, then he's going to have very different ideas about how dangerous guns are from somebody who has egalitarian, communitarian values. For the hierarchical individualist, the gun is kind of a piece of equipment, especially if you're a man. They enable certain kinds of hierarchical roles, like being father, provider, protector. They symbolize certain kinds of individualistic virtues, like self-reliance, self-integrity, and honor. Whereas the egalitarian, communitarians, see ownership of a gun as kind of denigration of collective identity, collective engagement with other people's welfare. You're gonna do it on your own. It's kind of more against the law, against all. And then there are also associations between guns and various kinds of outlooks like patriarchy that they're skeptical about. So people have these values. In our work though, we're studying how does that influence assessment of information about risk. Do people tend to fit their assessments of risk to their values? What's good is as a matter of morality shouldn't be what's bad for society. What's base isn't going to be helping us out—a kind of dissonance avoidance strategy on top of the values at that stage.

So that approach to thinking about people's identity, how do you see it as different than others' ways of dealing with it?

Two principal differences, and one has to do with the method. And I've described that in a lot of the scholarly work we do that if it's for the general public we will use these culture measures. There are other people who have different kinds of value measures but probably are doing the same thing. They have the same idea that people will process the information in a way that's congenial to their identity measured with other kinds of variables. Those could be right or left ideology ones, for example. Or they could be some other kind of scheme that is at least related to the one we use, but is different. So that's one distinction, like how do you operationalize the identity of people that's motivating them to reason in a certain way. The other is just a difference in construct. Maybe even a different kind of problem that they're thinking about. The personality measures are pretty different from what we use, so things like [the big five](#). There, people aren't thinking so much about people in groups, they're thinking much more about just an individual personal attribute. They don't need to worry about whether that has a kind of providence of group membership, and maybe even that would complicate things. But certainly the personality measures are very different. They're doing something different from what we're doing.

In the science education literature, they talk about the idea of having identity as a scientist or as somebody who is part of a scientific community or somebody who could do science. Any sense of where that would map on?

I think that there are a couple things that are relevant in thinking about that and the relationships to the work that we and others might be doing on public risk perception or on science communication. One is that the people involved might be using a different kind of reasoning process if they're in a professional domain. So professionals, whether it's science documentary producers, or scientists. We did a study on judges and lawyers versus the lay public. They might have a way of assessing information that avoids many of the kinds of confirmation biases and dissonance-avoidance strategies that we usually look at in our work when they're in their own domain, but then when they're not in their own domain they're very likely to display the kinds of things we're talking about. And we've done the research I mentioned on judges and lawyers, and that's what we see there. If they're in domain, they think like a lawyer, which is very distinctive, but they still have the same kinds of reactions and information about risks. So that's one thing to think about with the STEM people. The other is like whether, in fact, being somebody who is involved in the study of science furnishes you with some kind of habits of mind that generally work against these group kind of dispositions and maybe they do. I think I would say that there are certain kinds of individual differences that are relevant to this effect. And then those might be correlated a bit with being in the sciences. And maybe that's too abstract, but we studied science curiosity, for example, and science curiosity, I think, it's connected to an alternative identity that people who are members of these groups can have. But it tends to mitigate some of the effect. So I think more science curious people who are doing STEM and becoming "science geeks" so you would try to figure that out. But for sure I've seen work that shows that people tend to have

very domain-specific immunity to these kinds of effects. It's not that they're different kinds of people reasoning in a different kind of way generally.

At AAAS last year, you gave a [talk on science curiosity](#). Can we talk a little bit more about how you think the concept of [science] curiosity might be related to the concept of a STEM identity and why that's important?

Well, I would say that this disposition we measure with a scale for science curiosity, it seems to predict that people will have a kind of resistance to motivated reasoning. At least when people are in a domain in which what they're trying to do is enjoy science knowledge for its own sake, they're reasoning very differently from how they would reason outside of that domain and how others who probably aren't as interested in science reasoning, even in the domain of watching a science documentary. But there is this relationship between being curious about science and not showing as strong a degree of the motivated reasoning as people who are moderate or low in science curiosity. That might actually be an influence that works within the STEM field or within professions that use that kind of science. But I don't think it's connected specifically to the identity of scientists. We see lots of people who are only modest in their abilities to comprehend scientific information who still have very high levels of science curiosity. Here's something: The principle of perplexity. Every time you think you've gotten some data that helps you answer one question, there is a conservation of complexity so that you have at least one more question that you realize you don't have any answer to, and so you're getting to this. I'm not sure what the relationship is between science curiosity and going into the STEM programs. But if it does motivate people to do that then they're going to have this resistance. But it might be just because they're curious people, not because they happen to be scientists.

I can imagine that there are people who are curious about science who are not scientists. But I can't imagine somebody who is a scientist who is not curious. Really, there's a quadrant.

Well, maybe. But maybe they just have a kind of narrower scope, too, for their curiosity. I'm just conjecturing that there are people who are going to trip up if they're trying to do conditional probability problems who aren't very adept at recognizing that when you have covariant essential kinds of reasoning tasks for science can still have high science curiosity that they can still enjoy just the spectacle, the kind of awe of people using scientific reasoning to solve these kinds of problems. At the same time, it isn't the case, at least when you look at a general public sample that everybody who can do the conditional probability problem blindfolded or detect covariance from 800 meters, they just don't care. They're not really interested in science that they're good at, that kind of stuff. But then it doesn't translate, at least in the kind of intrinsic interest in science that we're trying to measure. So how it's distributed among scientists would be an open question. Give me a sample, I'd love to find out.

We've talked about measurement. And we talked a little bit about the cultural world views. So this introduces three things. Because there's this question about intersectionality and how things overlap.

Actually, that's a very relevant and interesting question because we oftentimes see interactions between the world views and other kinds of characteristics. So somebody who's a hierarchical individualistic, it will matter a lot whether that person is white and whether the person is a man. There's the white male effect which everybody's probably familiar with that suggests that white males are just less concerned with all manner of risk than minorities or women. But it turns out that that's a little overstated. That the effect is being driven almost entirely, at least in the domains in which people are measuring this, by white men who happen also to be hierarchical and individualistic. You can control for their values, than people who are egalitarian, you don't see the same effect. And so I think it's the identity itself has something to say about how people should behave and think based on their gender and their race. So that's really quite interesting.

One thing that's not on this question list, but I think is important for understanding your perspective, is the question of when people choose to use a particular identity, and those factors that make it more or less likely that someone might draw on one identity versus another.

Well, people do different things with scientific information. One of the things they might do is just either cherry pick or read it in ways that are supportive of the kinds of factual claims that have become identified with their cultural view. But at least some of those people may have something else that they do in their life that involves using science to guide them in making accurate decisions. And there's a literature on this. And so you have characters like scientists who don't believe in evolution but still study it or use parts of the evolutionary theory in their work. Maybe they're doctors looking at things like genetic propensity to diseases. Well, in effect, and this is work by a man named Solomon Hameed, they think one way about the theory of evolution when they're at work where they use it to be good doctors and another way about it at home being good Muslims, and where that role is enabled by a certain kind of skepticism. You have a similar thing that seems to be going on with farmers who are extremely skeptical about climate change but probably use climate change science more than any other private sector or group especially would. And then there are too, like I said before, things that are probably extensions of this, and they all fit together in some way. But people who are in different domains using their habits of mind in ways that are distinct, the habits of mind they would use to think about science in a setting in which their group identity is more salient. Like their cultural identity is more salient. I would say it's really an important thing to study how the different kinds of reasoning styles interact. Is it the case that people who have a cultural world view have different attitudes about science when they're in their science-use domain? I think everybody has that to some extent. But it's easier to observe and think about when it's somebody who has a professional domain.

The ones you talk about were contextual ones that come with workplaces or different parts of their life. What about in the more broad—you've also written about the broader communication environment. Things that communicators do that might lead me to—

Well, I think that everybody—people have these world views. They probably figure out what science knows actually in part through the contact that they have with other members of their groups. All of these groups have people in them who know a lot about science. They all have means of transmitting that knowledge to their members. And obviously if there was a group out there that consistently misled its members about what science knows it probably would be at a real disadvantage in perpetuating itself against other ways of life. So most of the time, the kind of contact that people have with their group probably helps them to figure out things that they aren't in a position to figure out by themselves. And also they're not every day talking to scientists about these things, they're talking to the people they know. At the same time, there can be a kind of a pathological version of this mode of science comprehension if the identity that people share in that group becomes entangled with some position and that's at issue in science. Then you're making them choose between behind who they are and knowing what science knows. And if you put them to that choice, then people are going to resolve it in favor of being consistent with other people who share their identity. And so you get kind of stuck in that way. That's something you should try to avoid happening, and if it does happen, fix it.

Can you give examples of times that science communicators sort of pushed people into . . .

Well, sure. I think actually it's quite interesting to try to imagine cases where things could have gone either way. But the HPV vaccine is a great example. It's the only childhood vaccine, universal childhood vaccine, that the CDC hasn't made onto the list of vaccines that are routinely required as a condition of school enrollment. And the reason is is that it went through a different sort of process from every other childhood vaccine. It's introduction to the public was through democratic politics because science communicators, but mainly private interest, initiated a legislative process to consider the risk and benefits of the vaccine. In all the other cases it's been administrative and so people are learning this information really only at the point where they're going to be using it from somebody who's a professional like their doctor. So that's a good example of how the science communication environment, which is just the sum total of cues and influences that help people align themselves with the best scientific information, was distorted and denigrated. And I don't think intentionally at all. I mean, nobody could have wanted that. But at least by a certain amount of recklessness and opportunism by certain science communicators, maybe professional ones but maybe too some who are just parts of different professions, i.e., market-driven versus the professions. Everybody made that mistake to some extent.

What about in the case of climate change?

Yeah. And I think something like that happened at some point with climate change. It's a premise of our research that no technology or form of science is born with the kinds of entanglements in people's identity that causes polarization. Something about the career of that risk caused that to happen. There's too much variance over time and across space to think that the potential to cause these sorts of polarized disputes is essential or resides inside the risk. Something happens. With climate change then I'm convinced that that is the story, but I don't know what the story is. I mean, there are people who've done really interesting stuff on how climate change attitudes have changed over time and what the relationship was between that science and the political parties and so forth. But I still think that it's just so vast and complicated and a lot of it happened when people weren't looking, that it's going to be hard to reconstruct what happened there. Unlike [the] HPV story, because it happened while we were watching. We knew what to look for, and it was relatively small.

But I don't—I mean, even in climate change there's too much variance across countries for you to think “well, it has to be something inherent in the risk itself.”

Are there issues that were initially entangled in identity that have become untangled?

Yeah, well, maybe this is an example—it's smoking. People think that attitudes change because of information. They're most certainly wrong, I mean, the peak smoking in the United States was probably 1979, and we didn't have the internet, but it still didn't take that long for the surgeon general's report to percolate out to society. People knew about that. It was only when public health officials started to untangle, disentangle cigarette use from various kinds of identities, and cigarette companies were very good at this. They had Marlborough Man for one group, but they had Virginia Slims, right? And that's what made smoking seem cool to people even though they had that knowledge. That's what the public health community took aim at. Whether people know more about cigarettes? I don't know if that's the case, but they definitely have a different attitude about it. And you can just go to Europe, for example, and you think that these things are driven by knowledge, if you go to the Netherlands, in addition to seeing people all over the place on their bicycles they have cigarettes dangling out of their mouth. So there's a lot of variance in that too. A lot of space that makes you realize that these are mutable kinds of associations.

Let me see, we talked about tools and resources.

Yeah, I mean, I think these are tools—the kinds of empirical methods that we're using that would enrich the practice of professions that use science. And we talked about our science documentary use. But I think that it's still going to be the case that those professionals are gonna need the assistance of social scientists who study this even if it's fairly perfunctory, just to test hypotheses. You know, there's a kind of division of labor on these things.

When you think of people who are doing the most interesting work on identity and science communication, who do you think of?

I think of lots of people that I've worked with, that's my M.O. [modus operandi], I try to find people like you and like them and examine our shared interest. But I think that [Hank Jenkins Smith](#) is doing great work. [John Gastil](#). But, you know, this is identity in the form that I described. And I realize it shouldn't be a contested kind of concept but that people are doing different things with identity, that's clear. It's just a kind of scholastic mistake to say, "well, we should have one understanding of what identity is." So if I think of the people who do that work, e.g., [Ellen Peters](#), I mean, some of these people are looking at how identity—the group identify—affects people's information processing [and] interacts with all kinds of other things. Like on these deliberative panels in John Gastil's case, or in Ellen Peters case, numeracy. A certain kind of critical reasoning how does that interact with—and ironically surprisingly that the more science comprehending you are, the larger usually the effect that a motivated reasoning has on your positions on these entangled risks.

We should talk about that a little bit. This idea, and it's one of the truly fun things in social science that's not obvious, right?

Yeah, not obvious.

Can you talk about this idea that sometimes identity and science knowledge interact in a way where they have the opposite effect than what you might think?

Well, a perfectly plausible hypothesis would be that the reason we have disputes and confusion and conflicts about risks like climate change is that people don't know a lot of science, and we don't think the way that scientists do, i.e., scientists are more analytic, deliberate, conscious. They use the slow kind of reasoning that [Kahneman](#) describes as "[System 2.](#)" Whereas members of the public tend to think of things in a rapid, intuitive, largely unconscious way, it's a fast "System 1" way of thinking. And you might have thought well, people who use System 2, they understand the evidence better and can reason about it. They're gonna basically go with the evidence. Where the people who don't understand how to think that way are likely to rely on heuristics like "what do my friends think?" and become polarized. But we have done, and others too, lots of studies that show that the people who are the most polarized are also the most cognitively proficient—the ones who are mostly likely to be using System 2. And at that point you have to kind of reevaluate what you thought was going on when people were forming these identity-expressive or identity-protective kinds of risk perceptions. They're not making a mistake. The problem isn't that they're irrational, the problem is that they're too rational. They're engaging this information in a way that's most relevant to their lives, and nobody, no individual member of the public, can do anything about climate change. Their carbon footprint is too small, their boats are just getting lost in the sea of boats. It doesn't matter if they make a mistake in this context. But if they make a mistake in their own community, given what climate change has now become a kind of symbol of group loyalty, they could be in a lot of trouble. So it makes sense for them really to use their cognitive capacities to understand what the relationship is between these issues and

their identity. And the more cognitive horsepower that you have right beneath the hood, the more proficient you're going to be in doing that. It's a kind of System 2 motivated reasoning. And that's something we've been studying about identity, including with experiments that will catch people in the act of using these kinds of actually remarkable and beautiful capacities to reason well in a way that actually perpetuates their belief in the position that's dominant in their group.

Is there anything else I should ask about identity?

Okay. Yeah, you know, at least I am a real, just instrumentalist. I'm trying to do what makes sense. And my thought isn't that there really are hierarchical individualists or something like this. All of these things are models, like the [Bohr-Rutherford atom](#). If they work, if they enable people to understand and explain behavior, to predict it and also to engage it in ways that are positive for social welfare, then that's a good theory. A theory isn't good because it's true in some sense. It's unlikely that a theory that didn't have some points of contact with these things we can't see or explain would be very useful. But in all these cases, to me the question is only the utility of the views, and to me that's what is interesting for people who do empirical work. To test which of these theories will be the best for us, unhindered by the idea that somehow you're describing a reality out there. These things are unobservable, and we try to have theories about them based on things we tend to observe. The one that works best—that's the one we should be going with. Or the ones that are best for this purpose, as opposed to that purpose that's what our attitude should be.

What is STEM Identity? An Interview with Angela Johnson

On December 13, 2017, [Tina Phillips](#), Research and Evaluation Manager at the Cornell Lab of Ornithology, interviewed [Angela Johnson](#) to understand her thinking and work on the topic of STEM identity. Dr. Johnson is a Professor of Educational Studies at St. Mary's College of Maryland. Dr. Phillips conducted the interview as a member of the Center for Advancement of Informal Science Education (CAISE) task force on evaluation and measurement and co-Principal Investigator of CAISE.

A video of Dr. Johnson's interview, as well as interviews of other researchers, is available at [InformalScience.org/identity](https://informalscience.org/identity).



Tell us about the projects that you've done that focus on identity.

I've studied the identity of women and girls of color, studying STEM at the K-12 level a little bit but much more at the university level.

Across those projects, how did you define identity?

The way I think about having, for example, a physics identity, right now my own work is more influenced by the way that [Zahra Hazari](#) and her colleagues [reinterpreted my earlier work](#). But when I think about a person having a STEM identity of some kind, what I think matters is how they see themselves. Whether they see themselves as having an affinity to the field and what others reflect back to them. So I see whether they recognize themselves as belonging in the field and whether other people recognize them as belonging to the field. And also whether other people recognize them as not belonging and interfere. They don't necessarily affect a person's self-identity as belonging in STEM, but they interfere with the person's actions. They interfere with the ability for the field to embrace them.

So they set up barriers?

Yes. They keep people marginalized and pushed aside. A story that I was told many years ago was about a woman who was working in a lab, just an undergraduate research experience, and while she was in the lab she had to put a Sharpie pen on the neck of some mice and jerk them by the tail to break the neck. It was part of the research protocol. And she said that she got a lot of hassle from other people working in the lab not because she wouldn't kill the mice, because she would, but because she didn't want to kill the mice. She was getting the message that she was too girlie to be there. The ability to kill a mouse, to take a mouse out with your bare hands, is not actually related to whether you can contribute to the STEM field. She had a strong feeling that she belonged there, but she was being pushed aside nonetheless and wasn't able to engage fully in some of the activities that other people expected her to do to show that she belonged because she was doing it in some way they perceived as the wrong way.

A student I interviewed much more recently was also doing an undergraduate research experience. It was in the summer, and she was the only woman in her lab, the only undergraduate, and the only person of color—so she was triply different from anybody else in the lab. One day someone bumped her, and a chemical got spilled. Then somebody in the lab started saying, “We all know who did that.” And they turned, invited everyone else in the lab to laugh at her, and then said, “How does it feel to have the boy's club laughing at you?” So although she had a perfectly strong affinity to physics that continued beyond that day, she never could continue to interact in the lab because she was so concerned about being marginalized. She never spoke for the rest of the summer. Her self-identity, her recognition that she belonged there wasn't impacted, but her belonging in that lab setting was impacted in that she could no longer get out of it what she had come there to get, which was to participate in the life of a research group.

I think that identity in the sense of an internally felt process is one thing, but your ability to step in and occupy a legitimate role in a setting is another. It's at that level of identity, of being able to legitimately occupy a role, that other people recognize as important or valuable. That's where problems crop up and where what other people see when they look at you can start affecting whether you can assume the identity of a physics student, let's say. Regardless of what you feel inside.

Those sound like external facts, right?

Yes.

There's the internal piece of what you can occupy and then there are external factors.

Yes. For me, as an anthropologist, I'm interested in the external factors because I think how you feel inside might affect your motivation and your ability to persist in the face of obstacles. I'm more interested in the characteristics of the setting and in determining how to create settings where people's external perceptions of you are

less likely to be able to shove you to the side, or where they're less likely to have damaging external perceptions—literally damaging your career.

Why, and in what ways, do you think identity matters for science learning or science communication? Can you say a little bit more about why you think it matters for science learning and science communication specifically?

There are two senses of identity. One is something that's intrinsically felt. Without an affinity for science, your ability to learn science and communicate about science is going to be affected because you're not going to be very motivated to do it, and you don't care. In terms of the sense of identity being whether other people recognize you as belonging in a setting, if you have to constantly fight to be given legitimacy in your setting, it's harder to learn because you have two tasks. Learning science is hard enough without having to constantly prove to other people that you belong there. This external sense of identity as a role that you can step into easily or with more difficulty has a huge impact on your ability to learn science. It also affects whether you can communicate science. If people don't perceive you as a legitimate member of a science community, they're not going to think you belong. They're not going to buy your communication. They're not going to take your communication seriously if they don't think you're a legitimate communicator, a legitimate member of the community.

There are a lot of ways that people approach identity. How is your approach distinct from other approaches? We've been talking implicitly about science identity, but some people are talking about STEM identity. Do you think there is a STEM identity? How is your approach distinct from other approaches to identity?

I think that often other people think about identity as something internally felt. I'm talking about how people are recognized in a setting as belonging or not belonging and how that recognition affects the kind of actions and opportunities available to them in a setting. I'm talking about the way that powerful figures in a setting may grant a person legitimacy or may marginalize them, regardless of how the student feels on the inside, regardless of how the student identifies in a more psychological sense. I think that the ways that people are or aren't recognized in a setting are intimately tied with their body, with their physical markers of yet another kind of identity, which is the meaning people make of your gender, your race or ethnicity, and other aspects of your appearance.

How do you frame identity in power relationships? Is that the language you would use?

What interests me is the way that power gets divvied up in particular settings. Whether the way power gets distributed within that setting is in alignment with the larger status quo or whether it can run counter to the status quo, and what are characteristics of settings where the way power is distributed runs counter to the

status quo? That's the project I'm working on right now. Looking at physics and math and computer science departments where women of color are finding it easier to thrive and persist in their studies because they are in a setting where they're less marginalized. What are the characteristics of that? What has to happen for that to be the case? I'm really interested right now in what actions professors can take to push their departments toward this counterculture. Toward a culture that runs counter to the larger cultural features.

How are you currently measuring identity in your work?

When I've worked with identity I've always looked at ways that a person can present themselves in a setting that they are celebrated or admired in that setting versus ways of being and acting that are marginalized or less successful in a setting. For instance, in a study I was working on a couple of years ago I interviewed students about what their lives were like while studying physics, math, and computer science. I listened to the kinds of things they said that they and other students did and the behaviors that they told me students engaged in. I attended a lot of classes to see what I could see, and then I interviewed a lot of professors and asked them what they considered to be a good student in their field. From that I was able to sketch out the kinds of students that are considered typical and optimal in these settings. I was studying settings that I had already identified as counterculture. What I found is that the students talked admiringly about people who were friendly, worked together, and worked hard. The professors were saying they liked students who asked good questions and who worked together and helped one another. They were creating an identity of a good physics, math, or computer science student that wasn't based on natural ability or competition; instead it was based on collaboration, hard work, and supporting one another. The word that they used over and over was "friend," "friendly," "friendship." Those three terms came out consistently. I was at the first day of a calculus class, and the professor said everybody's going to make a friend; to get through this class you've got to make a friend. The professor stood there waiting until everybody grudgingly turned around and introduced themselves to other people. The students would say things like, "I really love this major because I have so many friends." And they would say of the professors, "they're so friendly." I was stunned at how often it was coming up. It was a major characteristic of the identity that was celebrated in this setting, and that's what I mean by identity.

So that's a qualitative approach?

Yes.

Is there another methodological subtype of measurement that you would classify that as? Is it phenomenological?

I would just say that my work is ethnographic. I'm an anthropologist, and it's just classic ethnography. Looking at the things people do and say, the things they use and the shared meanings that are attached to those actions, speech, and objects.

Do you think that it's possible to create tools for measuring identity that practitioners or evaluators could easily use?

Sure. I love Zahra Hazari and her many collaborators' work. I think their work is wonderful.

Can you elaborate on that a little bit?

They have a questionnaire that they give to students. They've piloted it on high school students, but they have also used it on college-aged populations. They ask the students questions about whether they recognize themselves as belonging in various STEM fields. They've modified it for different disciplines. They ask students about their experiences that would suggest that other people recognize them as belonging. It's a nice little quick and dirty measure of a student's identity in the sense of self-recognition and recognition by others.

But a tool for the student—you're asking the wrong person. I was astonished when I saw what everybody had done with the ideas that [Heidi Carlone](#) and I put forth 10 years ago now. I was astonished they had made that into an instrument that I thought had good face validity.

I started out studying physics, and I ended up studying anthropology because I'm interested in the things that people may know but they don't know that they know, and it's really hard for them to tell you what they don't know that they know. You can only figure that out, it seems to me, by long and thoughtful observation until you start noticing patterns that aren't apparent on the surface.

I don't know how you make a fast instrument to do slow observations. But I think that somebody else might be able to come up with it. That's just not me. That's not my purpose. I wish it were. I would feel really smart if I could both do the long slow work and also the fast clever work.

In your work, do you think about how other identities, for example, gender, race, socioeconomic status, etc., might overlap or intersect with science identities? What role, if at all, does this intersectionality play in your work?

It's the centerpiece of my work. I love science and physics. I love it enough to be very dubious of the pipeline explanation that there are just not enough women interested, and we have to get them interested. I think it's inherently interesting. When you see a subject that is inherently interesting but there's a huge gender imbalance in who's participating, there's something about the culture. Physics is really great and there's got to be a lot of other women who also think physics is really great and who didn't go into it for reasons other than its inherent interest. They were discouraged by something. It's a great field, so if they're not going into it there must be a reason, and it must be some kind of obstacle that is different for men than women. And, yet, you'll go into a classroom and, although you will certainly see occasionally overt discrimination, you mostly see what appears from the outside to be a level playing field. I get really interested in the actions you need to do to be regarded as a good

student in this setting, an important student, a student who's good at physics, or name your STEM field. How are those actions subtly raced and gendered or how are the interactions in the room subtly raced and gendered? Because we've all heard the explanation that the problem is overtly prejudiced people, and we just have to wait for them to die, but that explanation falls apart. There was a study a couple of years ago where physics, chemistry, and bio professors at six different universities all rated the resumes for a prospective lab technician. The resumes were identical except for one was John, and one was Jennifer, and the professors felt that John should make \$6,000 more a year and was rated almost a point higher, I think, than Jennifer on a 5-point scale. The women were doing it as much as the men, and the young professors were doing it as much as the older professors. So the problem is not overt prejudice. The problem is some kind of covert discrimination. I think part of the problem is implicit bias, but with implicit bias, it blinds you to its existence. You don't know that you're implicitly biased. What interests me is looking at structures and policies and procedures and celebrated identities in a setting that are easier to access for some kinds of people than others in nonobvious ways.

For example, in a study I did a long time ago, I was looking at the way that at the end of class, or periodically throughout class, professors who were teaching in huge classes, in front of 250 people, were saying, "Does anyone have any questions?" And I thought that was great because with 250 students they couldn't do anything. Your instinct would be to talk as far as you can from beginning to end and hope that you don't lose control, but they were opening up the floor to questions and comments. But not all students were availing themselves of the opportunity, even though the professors didn't say, "okay, now it's time for white men to pose a challenging question and for white women to just ask clarification questions, and for the rest of you to be silent." That's what was happening. So then the question is why did this ostensibly open practice result in disproportionate participation? Why did different kinds of people take it up differently? What looks like a practice that's open to everybody actually plays to the experiences and socialization of certain kinds of people. First of all, women are already socialized to be deferential—to ask easy questions rather than to answer, to not make anybody look bad. So women were very unlikely to ask a question that challenged the professor's knowledge, and they were unlikely to ask a question that would draw undue attention to themselves. The women of color had all told me that as one of the three women of color, let's say, in this whole class, they already felt like there was a giant spotlight on them, and there was no way they were going to ask a question. And so what happened is you had these white men. I saw one guy put his hand up and start a long discussion of something he had just read in *Science* magazine that he felt challenged something the professor had just taught. He's going on and on, and he's perfectly happy to waste everybody's time in class. I saw some white women ask questions about what exactly is going to be on the test, and I never saw a person of color speak. And so I think that these larger structures, due to race and gender and other kinds of marginalities, affect people's abilities to access opportunities in classrooms and make ostensibly neutral practices reproduce the status quo.

You don't look at identity in the vacuum of identity.

No, in our hearts we can feel pulled to a discipline, but that doesn't mean we access it in the same ways, and we can't pretend that we have no bodies. We can't pretend that other people don't look at us and see things and that they don't slot us into the social matrix of domination as soon as they take a look at us. That would be naïve, and the only people who could believe that are people whose bodies are so acceptable that they don't realize that they're being slotted into the acceptable slot all the time. The "you belong here" slot.

A lot of people are talking about things like interests, motivation, and attitudes as outcomes for science learning. How do these connect with identity? How do you distinguish science identity from these other concepts, if at all? How do interest, motivation, and attitudes relate to identity for you?

Interest is key. You have to have an affiliation with the field. And the way that I think about identity, if you don't have an affiliation with the field you won't be entering the setting in which you're trying to be accepted as belonging there. But after that, I don't think of identity as residing in a person; I think of it as residing in a setting and who is and isn't regarded by other people in the setting as belonging, being valuable, and being an exemplary member of the setting. I think that if you enter into a setting where you would like to belong and be recognized as belonging, if you are unable to get that recognition in the setting, of course that can affect your attitude and your motivation because it's really discouraging.

But I don't think of identity as attached to the setting and not the person, but a person has motivation and an attitude, so I don't even think of them as relevant except as outcomes of what happens when you try to be accepted as stepping into a particular identity. I know it's really different than the way other people conceptualize these ideas.

We have lots of different perspectives that we want to share, so I don't think anyone has all the answers.

What we're looking for is a bunch of different tools to see what helps a particular person solve a particular problem in a particular setting.

Speaking of tools, what are some examples or resources or tools for measuring or understanding identity that you have found useful, if any? Are there some people or projects that you would recommend?

Well, obviously I would recommend Zahra Hazari's work and her colleagues. I love the work of my long-time collaborator, Heidi Carlone. And, for example, [Karen Tonso](#) and [Cory Buxton](#), but the reason I love their work is because they are all coming at identity in this same anthropological way, as something residing in a setting. In terms of theoretical uses of intersectionality, I really like to go back to the source and [Patricia](#)

[Collins](#)' work because when she talks about identity she also talks about what happens and the characteristics of a setting and not the characteristics of a person and the way that power gets played out in a setting based (I don't even want to say it like this) based on the bodies people bring into the setting. I'm not sure Collins would put it that way, but I like her work because it's about settings and not people.

I think that a lot of people, when they talk about intersectionality, think of it as something attached to a person, and I think of it as something that comes into play the moment you step into a setting. Different aspects of who you are become salient in different settings. Different aspects of what social location you occupy slash into prominence in different settings depending on the setting.

Beginning with the interest, your initial affinity and our interest, right?

Right, because if you don't have affinity you're not going to go there and try to be accepted in the setting.

Unless somebody's forcing you to or something.

Right. Exactly. Like your mama is making you go to med school, and we've all seen that student. And all you want to do is be a sociology major. I had a young woman whose mama was making her major in chemistry, and she was just not feeling it. So she wasn't even bidding to belong in the chemistry setting. She was just sitting in the back drooping and could hardly wait to get to her sociology class.

Anti-identity.

Yes.

Is there anything else about identity and science learning that you would like to share with this group that we haven't touched on?

No, instead I would like to tell you a story about my student who did not want to be a chemistry major. In her dorm, a first-year student was in an apartment with a bunch of other students, and their door was right next to the entry and exit door to the dorm, and he hung a giant Trump flag in the dorm. All the students on the other side of the hall hung rainbow flags, which I thought was funny. But a student put a note up, which I thought maybe this was a little over sensitive, saying, "It makes me kind of uncomfortable for you to put this flag up here because of his support of white supremacy." So then he put a sign up next to that saying, "It's a flag, deal with it." And then the whole campus got into a giant debate about *is it a flag, just deal with it?* All except my little not chemistry major. She put up with it for two days, and then she just got tired of it and started following him all over campus. When he sat down at lunch, she got her tray and sat down in front of him. Everywhere he went, she followed. He tried to lose her, she showed up at his dorm room, and he said, "How'd you get here?" And she said, "Dude, everybody knows where your room is. That's the point." And then he just took the flag down. It only took two hours of a mad black woman to start following him around campus, and he took the flag down.

That's fantastic.

But his principles were really, really strong as long as he didn't have to face a black woman for two hours, and then he found they were not as strong as he had thought.

As long as he didn't have to own up to it, right?

Yes. Exactly. During lunch and stuff. That's just wrong. How could she make him look at her during lunch? That's not fair.

That's great. Thank you for sharing that.

It's been really, really fascinating. I love the perspective of thinking about it through the setting because I have looked at it very marginally, and it's always been from the person internally, so to have this other perspective is really helpful.

But the thing is, regardless of how you feel inside, for those of us who are studying this, we would like to make settings less toxic. We have almost no control over how a person feels inside. All we have control over is the setting. So all this focus on trying to change what's inside of people, to cultivate some kind of identity, well, I guess we could do that, but I think that there are plenty of people who already strongly identify with the field and are being forced out. Why don't we first work on keeping the people who already want to be there? It's very difficult to change another person. As professors, we have a lot of power to change our setting.

The woman who told me the story about the men in her research group asking her how it feels to have the boys club laughing at you was in another setting where she has also done work. I was interviewing and observing there, and I watched faculty members go up and intervene in lab groups where male students were trying to control all of the equipment and say things like, "Everyone needs to touch the equipment. You're monopolizing the equipment. Stop monopolizing the equipment." So they were conveying strongly that in this setting being a good member of the setting means sharing. This same woman in one setting was marginalized and in another setting her professors came in and were deliberately creating an environment where the actions that were appropriate to engage in were actions that were straightforward for her, like collaborating. So I'm much more interested in the actions that professors can take that they have access to. I can't go in and move the levers in somebody's head, but I can demand that students treat one another a certain way and marginalize those whose treatment is marginalizing other students, if that makes sense.