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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?