

# 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).



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## 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 OMSI 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 knowledgeable 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 McCree 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.