caise | center for advancement of informal science education

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 to 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 multiples 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.