

STEM Identity

A Reflective Tool for Educators

Over the last several decades, identity has become a hot topic in the field of science, technology, engineering, and mathematics (STEM) education. Researchers, educators, and policymakers are increasingly interested in understanding how children and youth come to identify with STEM topics and activities, how these identities evolve and change, and what we can do to help youth develop positive relationships with STEM. This interest is for good reason—there is growing research indicating that STEM identity is fundamental to how youth connect with STEM, inside and outside of school, and whether or not individuals pursue STEM-related careers and remain engaged with STEM topics in their everyday lives. Now, more than ever, we understand that supporting STEM learning and engagement is not just about skills and knowledge but also about how children and adults see themselves in relationship to STEM.

But as educators, **what role do we have in supporting STEM identities?** Would we recognize a developing STEM identity if we saw it? What would we do to support a child or youth who seemed to be forming a negative perception of themselves as a STEM learner? This reflection tool is meant to help address some of these questions and provide educators with practical strategies for noticing and supporting STEM identities in their programs.

How We Got Here

The tool emerged from three years of research with adolescent girls participating in afterschool and museum-based programs as part of the *Designing Our World* project. Led by the Oregon Museum of Science and Industry (OMSI), in collaboration with Oregon State University, Girls Inc., the Boys and Girls Club, and Adelante Mujeres, the project developed a series of integrated programs, exhibits, and community-based professional development experiences. These deliverables were designed to encourage adolescent girls from traditionally underserved and under-resourced communities to become interested in and engaged with the topic of engineering.

As part of the project, researchers from OMSI spent three years videotaping and collecting feedback from program participants in order to understand how these girls created identities related to engineering for themselves during the programs and how interactions with peers and adults influenced this process.¹ This study did not produce a

¹ Pattison, S. A., Gontan, I., Ramos-Montañez, S., Shagott, T., Francisco, M., & Dierking, L. D. (2017). *The Identity-Frame Model: A framework to describe situated identity negotiation for adolescent girls participating in an informal engineering education program*. Manuscript in review. Pattison, S. A., Gontan, I., Ramos-Montañez, S., & Moreno, L. (2017). *Identity negotiation within peer groups during an informal engineering education program: The central role of youth leaders*. Manuscript in review.

prescription for supporting STEM identity development. However, it did suggest ways that educators can notice youth identity development in action and create positive learning environments to support these identities. Although the tool was created through work with engineering programs in out-of-school contexts, we believe it is also useful for school- and community-based educators working with a variety of STEM topics.

Introducing the Tool

The materials provided in this guide are intended to introduce educators and program facilitators to concepts related to STEM identity and to help educators practice noticing and responding to the dynamics of STEM identity development in their own programs. These concepts are abstract, and we have accordingly provided a variety of materials to help make them more understandable, practical, and relevant. The tool includes:

- Background reading and discussion questions to introduce STEM identity and related concepts;
- Two example scenarios from our research to allow educators to practice recognizing STEM identity work in action; and
- A structured reflection tool to help educators observe and reflect on STEM identities in their own programs and plan ways to support identity development among their participants.

Using Reflective Practice

We recommend working through these materials slowly with several colleagues. For example, you might identify one or two other program leaders at your organization and schedule an initial meeting to review the tool and discuss the background reading. You could then plan a second meeting to read through and talk about each of the example scenarios. Finally, you could schedule time for one of you to lead a program while your colleagues observe so that all of you can collectively complete the reflection tool together.

Ultimately, this tool can be used in whatever way best meets your needs and best supports your ongoing learning as a professional educator. If you have not engaged in group inquiry or reflection before, you might want to start by reading some more general resources on these topics (see the *additional reading resources* below).

However you use these materials, we wish you the best in your important work supporting STEM identities within your programs!

Additional reading and resources about reflective practice and group inquiry:

- Cochran-Smith, M. (2009). *Inquiry as stance: Practitioner research for the next generation*. New York: Teachers College Press.
- Pattison, S. A., Cohn, S., & Kollmann, L. (2013). *Team-based inquiry: A practical guide for using evaluation to improve informal education experiences*. Retrieved from http://www.nisenet.org/catalog/tools_guides/team-based_inquiry_guide
- Preskill, H. S. (1999). *Evaluative inquiry for learning in organizations*. Thousand Oaks, CA: Sage Publications.
- The *Reflecting on Practice* program from the Lawrence Hall of Science: <http://mare.lawrencehallofscience.org/professional-development/reflect-on-practice>.

Introduction to STEM Identity

The information below can be discussed with your colleagues and other educators using the reflective questions at the end of the document as a catalyst.

One of the most confusing aspects of the topic of “STEM identity” is understanding just what that term means. Various research articles provide examples of identity defined as an individual’s perceptions of their abilities related to STEM, their career aspirations, their relationship with STEM relative to their gender or cultural identities, the ways they position themselves as STEM learners during specific experiences, and more.

In all likelihood, these different definitions are each useful and true in their own right. In our study as part of the *Designing Our World* project, however, we took a much more focused approach to understanding identity. We were interested in how a particular youth communicated her STEM-related identity in a specific moment with specific people. In other words, we didn’t worry about what a participant might tell us on a survey or in an interview. Instead, we wanted to see **who they tried to be while they engaged in the program**, including how they tried to position themselves as knowledgeable, competent, and skilled during the engineering activities and how they tried to take on different roles with their peers, such as leader, supporter, or independent participant.

This perspective is often called *situated identity*,² and it is something we are all familiar with, even if we haven’t thought about it before. For example, when you are leading a program with a group of middle schoolers, there are lots of aspects about your identity that you might be communicating, intentionally or not: your knowledge of the topic, your authority as the program leader, your confidence (true or not) as someone who has facilitated the program before, or your passion as a teacher. However, these “situated identities” can quickly change. As the program ends and your colleague enters the room, you might shift to communicating identities about being a good collaborator, a knowledgeable professional, or perhaps just a friend.

This process, which we could call *identity work*, doesn’t happen in a vacuum. As you communicate information about your identities, individuals around you are communicating back. Sometimes responses from those around you support your intended identities, like when a colleague compliments you on the program you just ran, which you developed and were hoping would go well. On the other hand, sometimes those responses

² Penuel, W. R., & Wertsch, J. V. (1995). Vygotsky and identity formation: A sociocultural approach. *Educational Psychologist*, 30(2), 83–92.

undermine your identity work, like when a group of program participants doesn't seem to quite buy in to the notion that you should be telling them what to do.

Activity Frames and Identity

In our study with adolescent girls participating in an informal engineering education program, we observed this process of identity work happening constantly. As with all of us, the girls regularly tried to be viewed as skilled and competent as they worked on the engineering activities, sharing their successes with others, making suggestions, and responding to adult questions. Some of the girls also seemed to work to be seen as the leaders and most successful members of their groups, highlighting their own success at the expense of others, racing to complete activity challenges, and becoming frustrated when they encountered failure. Other girls, in contrast, communicated identities more closely associated with collaboration and support, including helping other team members, celebrating group success, and working to ensure equal participation.

Although watching these identities in action was interesting, we also learned something even more intriguing: As girls engaged in the programs, they not only worked to negotiate their identities but also communicated implicit understandings and expectations related **what the activities were really all about**. We called these implicit understandings negotiated among program participants *activity frames*, recognizing that they represent the multiple, sometimes competing and sometimes aligned, lenses through which participants filtered their understandings of the experiences. For example, for some girls these activities were ultimately about competition—who could get the right answer the fastest. For others, these were collaborative experiences, with more of a focus on sharing, participation, and group success. Similarly, girls communicated different expectations about what engineering meant in the activities. Although iteration is fundamental to the engineering process, which was stressed by program leaders, many girls still positioned failure and challenge as negative parts of the program, to be avoided at all costs.

What we found in our research is that these **expectations and understandings about the activities were critical to how youth were able to negotiate their identities**. For example, we saw at various times how some participants framed the activities as more competitive while at other times the activities were framed as more collaborative. For girls working to position themselves as the best and most successful within their groups, a competitive activity frame was often ideal, creating a supportive space for them to race through the activities, take credit for group successes, and elicit praise from adults for getting the right answer or completing the challenges. At the same time, other youth in the same group who seemed to be working towards more of a collaborative and supportive

identity often encountered challenges within a competitive activity frame. Their important role within the group might have gone unacknowledged and their attempts to praise group success or include other participants might have been overshadowed by other individuals working alone.

What do We Do With All That?

For educators, we believe that *activity frames* provide a useful perspective for understanding how to support STEM identities. By learning to notice different activity frames that we communicate or are communicated by participants, we can become more aware of the role of these frames in our programs and how they influence the roles and identities youth are able to take on during the experiences. And once we develop our noticing skills, we can also actively work to shape and guide these activity frames to create learning environments that support positive STEM identity development for all learners.

Discussion Questions:

- In your own words, how would you define the concept of “activity frames”?
- What are some examples of common activity frames in your own life (e.g., at work, at home, with friends, etc.)?
- When have you seen examples of participants in your programs negotiating activity frames related to either collaboration or competition? What about frames related to failure as a negative or positive aspect of the STEM learning experience?
- What are ways you as a program facilitator and educator like to frame activities in your programs? How do you think your intended activity frames might influence the identity negotiation of different participants?

Activity Frame Focus

Some example activity frames, and possible indicators for each, are listed below. There are likely many other activity frames that you could look for that are relevant to your programs.

- 1) **Activity as collaborative** - Participants interpret the activity as collaborative. *Potential indicators:* participants working together and supporting one another; claims of group success (e.g., “we did it!”); praising others; sharing materials and roles during the activities; and helping, supporting, and offering positive suggestions.
- 2) **Activity as competitive** - Participants interpret the activity as competitive. *Potential indicators:* independent youth work; conflict among the participants related to roles and materials; comments highlighting a focus on individual success (e.g., “I did it first!” or “I win!”); taking credit for other participants’ work; a focus on quickly getting the “correct” design or answer rather than trying out different ideas; negatively critiquing the work of others.
- 3) **Failure as a positive** - Participants interpret failure or challenge as a positive, constructive part of the STEM learning process. *Potential indicators:* positive emotional responses to failure; persisting through failure and trying multiple iterations; recognizing failure but attributing it to the materials and the design process rather than to one’s own skills or abilities; using humor to deal with failure and challenge; celebrating multiple iterations, multiple solutions, and collaborative work.
- 4) **Failure as a negative** - Participants interpret failure or challenge as a negative part of the STEM learning process, to be avoided at all costs. *Potential indicators:* negative emotional reactions to failure and challenge; comments focusing on past success rather than trying out new ideas or new designs; getting stuck or giving up after a failed design; recognizing failure and attributing failure to oneself rather than the process or the materials; being secretive or covering up failure; focusing on who has been successful and who has completed the activities rather than celebrating multiple solutions and the design process.

Practice Recognizing Activity Frames

Use the following transcripts to practice recognizing activity frames. Read the transcripts and use the reflective questions at the end to discuss possible activity frames, indicators of these frames, and implications for the identity work of participants.

Transcript #1

This transcript focuses on a small group activity in which a group of middle schoolers were working together to build a model of a zip line that could bring a Lego® figure—representing an injured person—safely down to the ground. Before the activity began, adult facilitators explained what zip lines are and how they can transport people in an emergency. Educators also discussed strategies that participants could use if they felt stuck during the design process. Among these strategies, educators encouraged girls to take a break, look at others for ideas, and “test early, test often.”

The transcript begins as three girls approached the table they were going to be working at. They looked at the materials and talked about the Lego® person for whom they would be designing their models.

Line no.	Conversation	Behavior
1	Participant 1: Ooh! I am using these, these are mine.	Grabbing all of the materials on the table and bringing them closer.
2	Participant 2: They are not yours!	
3	Participant 3: We have to be a team.	
4	Participant 2: We have to be a team—you can't just take it!	
5	Participant 3: You can't be like, hey it's mine! It's mine!	Using a mocking tone while grabbing materials.
6	Adult facilitator: Yeah, team work guys!	
7	Participant 1: Oh! Is that clean water?	Signaling the two-liter bottle that supporting one end of the zip line.
8	Participant 3: Yeah, but don't drink it	
9	Adult facilitator: It's not for drinking, it's just to hold it in place.	
10	Participant 1: Eww! What is this sticky clay?	
11	Participant 2: Yeah!	Using a sarcastic tone.
12	Participant 1: Wait! What are they doing over there?	Referring to other groups and walking over to look at the other tables.
13	Participant 2: Ooh! They have the smiley face things.	Referring to the binder clips.

14	Participant 3: The smileys.	
15	Participant 2: Seriously, I bet you she is going to tell us to copy it.	Referring to participant 1, who is bringing an example design from the educators back to the table.
16	Participant 2: We are not going to copy it, ok?	
17	Participant 1: I know, I'm doing this a bit different, I'm doing it again but I'm going to add that and a marble.	Signaling other materials on the table.
18	Participant 2: You can't just tell what you are going to do. We have to work together. You can't just say what you are going to do.	
19	Participant 1: It's not like, um, okay so you guys can do whatever you guys want and I'll make this.	
20	Participant 2: You can't just do that.	
21	Participant 3: You can't do that. You can't be like— wait, wait, wait, let me see this.	Grabbing materials and pretending to keep them to herself and cut a piece of foam.
22	Participant 1: No, don't cut it.	
23	Participant 3: No, I'm not going to do that. We have to be a team. We have to agree to cut it.	
24	Participant 1: Ok, I'll let you guys decide how you guys want to do it first.	
25	Participant 3: I think we should give ideas and talk about them.	
26	Participant 2: Yeah, we have to give other ideas.	

Discussion Questions:

- What types of activity frames did you see at play in the transcript?
- What evidence did you see (conversation or behaviors) of these frames?
- How do you think these activity frames might influence the identity negotiation of different participants?
- What are possible implications of these types of activity frames for participants in your programs?

Transcript #2

This transcript focuses on another small group activity in which a different group of middle school participants were working together on the same zip line activity described above. In this case, the group had been working on their designs for several minutes, sometimes working together and sometimes separately, and were beginning to test their designs on the model zip line.

Line no.	Conversation	Behavior
1	Participant 1: It's working!	Watching her design slide down the zip line.
2	Participant 2: No, it didn't go all the way. It has to go all the way.	Participant 1 walks away, looking frustrated.
3	Participant 4: Can I use that cup?	Asking for a plastic cup that participant 2 is using for her design.
4	Participant 2: No [name]!	Moving the plastic cup away from participant 4, who sits back and looks frustrated.
5	Participant 2: Let me see the person. Let me see, let me see, let me see!	Trying to take the "test" person from participant 3, who is still testing the design that participant 1 created.
6	Participant 3: No, it doesn't have to go all the way.	Arguing with participant 2.
7	Participant 2: Yes, it does.	
8	Participant 3: Does it have to go all the way?	Asking an adult program facilitator who is approaching the table.
9	Adult facilitator: What do you think? If this was a real zip line and it went to here and this was the land...	Indicating a stop point before the bottom of the zip line.
10	Participant 3: Yeah.	Smiling and agreeing with the educator that the cart has to go to the end of the zip line to safely deliver the person.
11	Adult facilitator: Hmm, it might be dangerous.	
12	Participant 2: Ready?	Preparing to test her design again.
13	Participant 4: I don't want to be in this group anymore.	Sitting back and looking frustrated.
14	Participant 3: Hah, yours stopped!	Playfully wagging her finger at participant 2's design, which stops before the end of the zip line.

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Identity Reflection Tool

Use the process below to practice noticing activity frames and identity work in your own programs. Then use your observations and reflections to brainstorm new strategies or program improvements for fostering activity frames that support STEM identity work for all participants.

Process: We suggest following a four-step inquiry cycle to notice and reflect on activity frames and identity work within your own programs:

- 1) **Plan** - *Before* the session, talk through the goals of your program and the relevant activity frames you would like to focus on. Think about and discuss with your colleagues what types of talk and behavior might indicate these activity frames, using the example transcripts listed above as guides.
- 2) **Notice** - *During* the session, think about how your words and actions affect the activity frames that emerge during the program. Consider taking notes.
 - What strategies are you using to try to promote certain activity frames?
 - What evidence do you see of your intended activity frames emerging during the program?
 - What evidence do you see of other activity frames emerging during the program?
 - How are participants reacting to the different activity frames?
- 3) **Reflect** - *After* the session is complete, set aside some time to discuss with your colleagues what happened during the session.
 - Overall, what activity frames seemed to dominate the program? Were different activity frames apparent across groups of participants?
 - How do you think your actions, intentional or not, contributed to these activity frames?
 - What are examples of your intended activity frames being supported by participants?
 - What are examples of other activity frames emerging that you didn't intend?
 - In retrospect, what influence do you think different activity frames might have had on participant identity work? Did certain activity frames support identity work for some participants but not others?

- 4) **Act** - Develop action items to improve the program and think through concrete strategies to improve the program delivery around the specific activity frame.
- What goals do you have for supporting activity frames in future program sessions?
 - What changes would you like to make to the program or your facilitation strategies to meet these goals?
 - From the perspective of the participants, how do you think the program could better support identity work for all participants?