# Family matters: A mixed-methods study of everyday science talk and STEM identity development

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Digital Presentation

FLORIDA INTERNATIONAL UNIVERSITY

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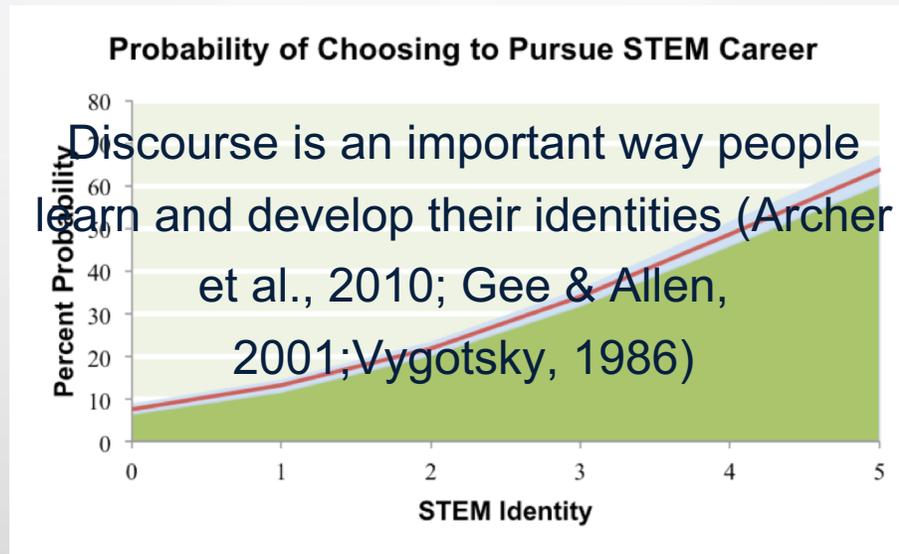4. Collective meanings & implications

# Challenges to STEM Identity

- Identification of the self as a "STEM person" (i.e., STEM identity) is largely connected with recognition and interest in STEM (Carlone & Johnson, 2007; Hazari, Sonnert, Sadler, & Shanahan, 2010)
- Students from marginalized backgrounds face obstacles in formal K-12 settings and brick-and-mortar informal STEM learning institutions (e.g., museums)
  - Individuals "like them" are under-represented in the curriculum (Guerra & Rezende, 2017)
  - Technical language over colloquial; science is context free, exists without people; predetermined body of knowledge (Archer et al., 2010; Calabrese Barton & Yang, 2000; Elmesky, 2005)
  - "Science museums...reflect and reify White, male privilege while Othering people outside this narrow category" (Dawson et al., 2019)

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# Identity Practices and Discourse

- Previous research (Dou et al., 2019) suggests that informal interactions in the home, such as talking about science, could be a predictor of STEM identity that circumvents the traditional barriers

Discourse is an important way people learn and develop their identities (Archer et al., 2010; Gee & Allen, 2001;Vygotsky, 1986)

**Probability of Choosing to Pursue STEM Career**



| Model-Level Statistics (N = 15,847) | | | | | | |
|---|---|---|---|---|---|---|
| | Regression Coefficients | | | | | |
| | Model 1 | | Model 2 | | Model 3 | |
| Predictor | β | t | β | t | β | t |
| Control Block A | (see study) | | (see study) | | (see study) | |
| K-4 Disciplinary | | | 0.02 | 1.83 | 0.01 | 1.34 |
| K-4 Talking Science | | | 0.11*** | 11.4 | 0.09*** | 8.54 |
| K-4 STEM Media | | | 0.08*** | 7.71 | 0.06*** | 5.46 |
| K-4 Competitions | | | 0.01 | 0.95 | 0.01 | 1.09 |
| K-4 Clubs | | | -0.02 | -1.90 | -0.02 | -1.95 |
| Control Block B | | | | | (see study) | |
| F-statistic | 139 | | 114 | | 142 | |
| Adj. R² | 0.11 | | 0.13 | | 0.29 | |
| p-value | < .001 | | < .001 | | < .001 | |

***p < .001

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# Research Questions

1. What are the differences in the associations between childhood science talk with different groups of people (i.e., close family, extended family, friends/classmates) and the extent to which a respondent sees themselves as a STEM person in college?

2. How do students enrolled in a STEM program at an HSI describe STEM recognition events from their childhood?

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# Study Site and Context

- **Florida International University**
  (Fourth largest public university in the country)

- **Number of STEM majors**
  - STEM Majors (n=88; 97%)
  - Non-STEM Majors (n=3: 3%)

- **Ethnic representation** (FIU 64% Hispanic)
  - Hispanic/Latino (n=79; 87%)
  - Non-Hispanic/Latino (n=11; 12%)
  - Missing Data (n=1; 1%)

- **Gender representation** (FIU 57% Female)
  - Male (n=53; 58%)
  - Female (n=53; 42%)

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# Quantitative Methodology & Findings

# Survey Development & Administration

- **Development of survey (Spring 2019, *N* = 91)**
  - STEM identity (Dou et al., 2016)
  - Talking science experiences (Dou et al., 2016)
  - Control variables: gender (binary), primary language, and home support
  - Intended as a pilot survey

- **Administered as a paper-and-pencil survey**
  - Introductory Physics II Course
  - Primarily Engineering, Biology, and Computer Science majors

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# Identity Items: Structural Validity

| Construct | Item | Standardized Factor Loadings | Mean | Standard Deviation | Cronbach's Alpha |
|---|---|---|---|---|---|
| *STEM Interest* | Topics in STEM excite my curiosity | 0.92 | 4.60 | 0.68 | 0.92 |
| | I am interested in learning more about STEM | 0.84 | | | |
| *STEM Recognition* | My teacher sees me as a STEM person | 0.77 | 4.30 | 0.75 | |
| | My friends/classmates see me as a STEM person | 0.82 | | | |
| | My family sees me as a STEM person | 0.72 | | | |
| | Others ask me for help in STEM | 0.76 | | | |
| *Performance-Competence* | I feel confident in my ability to learn STEM | 0.86 | 4.27 | 0.72 | |
| | I can do well on tests and exams in STEM | 0.82 | | | |
| | I understand concepts I have studied in STEM | 0.84 | | | |
| | I feel I belong in the STEM community | 0.80 | | | |

$X^2(32) = 66.6$, $p < 0.001$; CFI = 0.97; TLI = 0.96; RMSEA = 0.05; SRMR = 0.03; BIC = 9,392

# Talking Science Items

**Which of the following experiences do you remember participating in <u>between the ages of 5 and 9</u>?** (You may choose more than one answer)

| | |
|---|---|
| O | I talked with friends or family about science |
| O | I participated in science groups/clubs/camps |
| O | I read/watched non-fiction science |
| O | I read/watched science fiction |

**If you selected "I talked with friends or family about science" during the ages of 5 to 9 (i.e., during elementary school years), which of the following was true for you?** (You may choose more than one answer)

| | |
|---|---|
| O | I talked with my father or paternal guardian about science |
| O | I talked with my mother or maternal guardian about science |
| O | I talked with my uncle(s) or aunt(s) about science |
| O | I talked with my brother(s) or sister(s) about science |
| O | I talked with my cousin(s) about science |
| O | I talked with another family member about science |
| O | I talked with my best friend about science |
| O | I talked with my classmates from school about science outside of school |

# Talk experiences predict STEM Identity

| Regression Coefficients (STEM identity as outcome) | | |
|---|---|---|
| **Predictor** | ***β*** | ***t*** |
| Talk with friends and family | 0.49*** | 4.89 |
| Science clubs or camps | 0.06 | 0.55 |
| Non-fiction science media | -0.11 | -1.04 |
| Science fiction media | 0.03 | 0.28 |
| *Control Block* | -- | -- |
| Model Statistics | | |
| *F*-statistic | 3.38 | |
| Adjusted $R^2$ | 0.20 | |
| *p*-value | < .001 | |

Table 1. Linear regression model looking at the relationship between informal learning activities STEM identity. (Control block: gender, primary language, and home support.)

# ...especially talk with *close* family

| | Model $B_0$ (STEM identity) | | Model $B_1$ (STEM interest) | | Model $B_2$ (STEM recognition) | |
|---|---|---|---|---|---|---|
| | | | Regression Coefficients | | | |
| **Predictor** | $\beta$ | $t$ | $\beta$ | $t$ | $\beta$ | $t$ |
| Close family | 0.41*** | 3.54 | 0.45*** | 3.57 | 0.30** | 2.24 |
| Extended family | 0.02 | 0.14 | 0.02 | 0.16 | 0.06 | 0.48 |
| Friends | 0.04 | 0.33 | -0.01 | -0.10 | 0.06 | 0.49 |
| Control Block | -- | -- | -- | -- | -- | -- |
| | | | Model Statistics | | | |
| $F$-statistic | 3.16 | | 3.21 | | 2.29 | |
| Adjusted $R^2$ | 0.15 | | 0.15 | | 0.09 | |
| $p$-value | <.01 | | <.01 | | <.05 | |

Table 2. Linear regression models looking at the relationship between talk with particular groups of individuals and STEM identity, STEM interest, and STEM recognition. (Control block: gender, home support, and primary language.)

# Interview Protocol Development & Revision

- **Development:**
  - Who, what when, where? of conversations to find out about content, context, and structure
  - Review and revise with support from undergrad researcher/member of population
- **Piloting:**
  - Pilot with undergraduate researchers in Summer 2019 ($n = 2$)
- **Revision:**
  - Feedback from undergrad researchers
  - Feedback from advisory committee

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# Interview selection

- **Sampling efforts:** maximize diversity of demographic backgrounds, degree of STEM identity, informal STEM experiences (esp. talk), and area of study
- **Interviews ($n$ = 20):**
  - Majors in life science, physics, engineering, business; Pre-med and non
  - Ethnicity/race: Latine, Indian, South African, White non-Hispanic, African American
  - Immigration status: first, second, third, non-immigrant, and international
  - Male and female
  - Freshman → grad student
  - Varied sense of STEM identity (e.g. degree of recognition)
  - Varied informal experiences (e.g. presence/absence of talk)

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# Science talk: Interview coding

- **Began developing code list after first three interviews based on:**
  - Literature review
  - Emerging ideas from interviews themselves
- **Revisions to codebook following initial coding as a team:**
  - Combining, adding, removing codes based on redundancy
  - Putting codes in categories and sub-categories
  - Clarifying and renaming codes
  - Checking alignment with project research questions
- **Checking code performance**
  - Writing reflective memos after coding interviews, discuss as team
  - High agreement overall, exceptions clarified and discussed
  - Proceed coding individually, regular check-ins

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# Science talk: Interview coding

- **Tier 1: Emergent thematic**
  - Asking questions
  - Initiation of conversation
  - Trigger
    - Television
    - Schoolwork
  - Home-school connection
  - Recognition
    - Representation
    - Acknowledge interest
    - Acknowledge performance/ competence
  - Major life change
  - Family values connection

- **Tier 2: Person (if stated)**
  - Immediate family (broadly)
  - Mom (specifically)
  - Friend
  - Teacher
- **Tier 3: Place (if stated)**
  - Informal learning site
  - Formal learning site
- **Tier 4: Topic (if stated)**
  - Life science
  - Medicine
  - News
  - Aspirations/expectations

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# Spontaneous talk shapes STEM identity

- Incidents that arise organically are recalled by college students as formative interactions that supported their sense of capability and belonging in STEM by normalizing talking about STEM for fun

  - I think we had just seen the challenger and we had watched the video of it coming in, or we had watched the video of some spaceship coming in, and I was telling my dad like, why does it get so hot? Why does fire happen? And he was like, it gets so hot because of friction, so like the air and the surface of the spaceship were just sort of friction. And some point later he's pulling me from my arms on the carpet and he's pulling me around the house, and at some point I'm like "dad I'm gonna burn because of friction!" -*Sandra*

  - I've always been able to handle computers very well. I'm able to understand them and like if something happens to the computer my family always like asks me, "Can you fix it? Can you like see what's wrong with it?". And even though I have like no base and no experience, I'm usually able to get it to work or fix it. So I was like "You know what? Maybe, it's a sign." - *Selena*

# Ambivalent roles of schools & teachers

- Interviewees recalled formal experiences as limiting their identification with STEM

  - I was like, I've always liked science so I was like "Oh, I wanna take this advanced science class" and she [my teacher]- I remember the guy before me was this guy who never did any work in class, he was never doing anything, but she knew him because they were like a family friend and she's like "Yeah, I'm gonna recommend you for this class." So I was like "Oh, if he got recommended, I'm gonna get recommended, and I'll be in the advanced science class." And then I went up to her and she's like "Oh, I don't think that this is a good choice for you, like I'm gonna put you in the regular." And I was like "ouch." - *Carla*

  - [My teachers] were just, they would be extra aggressive towards me. I would ask a question, they would say they wouldn't answer it, and then someone else would ask a question and they would happily answer it. So I would literally just ask my friend to ask the questions for me, and she would. - *Nicki*

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# Collective Ideas

- Families provide a valuable source of identification with STEM, both through recognition and interest. This often arises naturally through spontaneous opportunities related to typical family interaction
  - Opportunity for empowering families
  - Contrast with other, more costly informal learning opportunities, which were not significant
- School interactions are not associated with STEM identity and may be detrimental
  - Students do appear able to develop STEM identity in spite of discouragement from formal learning, but supplements in future schooling, entertainment, and friends may be necessary

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# We welcome your feedback.

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NARST 2020 Annual Conference Presentation

**Family matters: A mixed-methods study of everyday science talk and STEM identity development**

**Dr. Remy Dou and Dr. Heidi Cain**

***Dr. Remy Dou:***

*Slide 1*
Hi, my name is Remy Dou and I am joined by my colleague Dr. Heidi Cian whom you'll hear from during the second half of this presentation. Here we discuss our research looking at the relationship between everyday conversations about science and the development of individuals' STEM identity. We've titled this presentation "Family Matters: A mixed methods study of everyday science talk and STEM identity development."

*Slide 2*
Because this is a mixed methods study, for the sake of organization we have divided this presentation into two parts: a discussion of findings from a survey of students and a discussion of findings from subsequent interviews with those students. Prior to this we will present our problem and theoretical framework and at the end we will discuss meanings and implications of our study.

*Slide 3*
Our study hinges on the findings of researchers in our community like Dr. Heidi Carlone, Dr. Zahra Hazari, and others who have found a meaningful and robust relationship between whether or not an individual sees themselves as a type of science person and that individuals' pursuit of science both as a leisure activity and as a profession. This science identity framework, or STEM identity framework, as we've more broadly encompassed it in our study, has been found to help explain behavior, engagement, and participation in science related contexts.

*Slide 4*
As per our theoretical framework, the salient factors that contribute to an individual seeing themselves as a STEM person are a sense of being recognized by others as a STEM person and an inherent interest in STEM content and activities. The former variable, this sense of recognitions, is particularly important. Unfortunately, studies in formal K-12 contexts have found that science, and STEM more broadly, is presented in restrictive ways that exclude individuals who do not look like or come from similar cultural backgrounds as science and scientists presented in classrooms. This is particularly true for children from minoritized populations in STEM. Some of these exclusionary practices have also been found in brick and mortar informal learning environments like science centers, as highlighted by the work of Emily Dawson. While this may not be true for every school or every science center, in part for these

reasons we turn our attention to science learning that happens outside of these settings in children's everyday lives.

*Slide 5*
Prior studies using nationally representative data sets indicated a strong relationship between having a STEM identity and pursuing a STEM career. When looking at informal learning experiences that may have contributed to STEM identity development, only two experiences stood out: consuming nonfiction and fiction science media (like books and television shows) and talking about science with friends and family. Of these two, the latter exhibited the stronger effect even when controlling for factors like home support of science, participant gender, and ethnicity. Given the work of Dr. James Paul Gee, Dr. Kelly Riedinger, and others who have posited a relationship between science identity development and discourse, we chose to further explore what the talking science experience may look like.

*Slide 6*
Specifically, we asked the following questions:
1. What are the differences in the associations between childhood science talk with different groups of people (i.e., close family, extended family, friends/classmates) and the extent to which a respondent sees themselves as a STEM person in college?
2. How do students enrolled in a STEM program at an HSI describe STEM recognition events from their childhood?

*Slide 7*
We conducted this study at the fourth largest public university in the country. Most of the students who responded to our survey were self-reported Hispanic students and given our interest in the experiences of STEM majors, nearly all of our respondents were majoring in a STEM field at the time.

*Slide 8*
[No narration]

*Slide 9*
We administered this survey in an introductory physics 2 course during the spring 2019 semester. Given that we administered it as a paper-and-pencil survey and answered questions about our study prior to administering the survey, we achieved a nearly 100% response rate. Most of our participants were engineering, biology, or computer science majors. The survey included three major groups of items: 1) items measuring participants' STEM identity, 2) items inquiring about participants' everyday science talk experiences, and 3) our control variables, which included participant gender, primary language, and home support around science.

*Slide 10*
Our STEM identity items were grouped around three constructs as per Dr. Zahra Hazari's discipline-based identity framework. We included items relevant to interest in STEM, items relevant to being recognized as a STEM person, and items relevant to having a sense of

performance competence in STEM contexts. The results of our factor analyses confirmed this three-factor structure, achieving excellent model fit value. We used a weighted average of these 10 items across the three factors to create our STEM identity variable.

*Slide 11*
Our science talk items came in the form of two questions. The first question primarily inquired whether or not participants remembered talking with friends or family about science between the ages of 5 and 9. The second item was directed at participants who indicated they had talked about science, and solicited information from them regarding whom they spoke to. We grouped these individuals into three major categories: close family, which consisted of parents and siblings, extended family, and close friends.

*Slide 12*
We ran a multiple linear regression model looking at the predictive value of informal learning experiences and STEM identity. Similar to our 2019 study, we found that remembering childhood talking science experiences was significantly related to individuals' perception of themselves as STEM people. None of the other experiences yielded statistically significant estimates.

*Slide 13*
We then tested three different linear regression models exploring the role that specific groups of people play during everyday science talk. We found that individuals who remembered talking about science with close family, that is parents and siblings, were much more likely to report a higher sense of recognition as a STEM person, a higher interest in STEM fields, and a higher identification with STEM. Having confirmed the relationship between remembering the experience of childhood science talk and STEM identity in our university context, and identified the importance of close family members, we then recruited specific students to further inquire about the nature of the science talk our respondents reported participating in as children.

*Slide 14*
I will now turn it over to my colleague will report on the findings from our interviews.

**Dr. Heidi Cian:**

*Slide 15*
Prior to collecting our qualitative data, we developed an interview protocol in collaboration with some of our undergraduate researchers, who are also members of the population for this study. First, Remy and I developed questions to elicit information about the content, context, and structure of the conversations students recalled. Then we reviewed and revised the questions with support of our undergraduate researchers, for instance by removing redundant questions or reorganizing the question order. We piloted the survey with these researchers, made additional revisions, and sent the protocol to our advisory committee, who suggested additional modifications to make questions clearer and the organization more logical.

*Slide 16*
Once we felt comfortable with the interview protocol, we were ready to select individuals for interview. We reviewed the responses to the survey from students who indicated that they were willing to participate in an interview for a small incentive. From this group, we selected an initial sample of a few students whose responses indicated a lot of talk experiences and a diversity of demographics, such as degree of STEM identity, presence of other informal learning experiences, and area of study. We continued this process of contacting small groups of students at a time to invite for an interview until we felt comfortable that we had reached data saturation. This chunked approach allowed us to respond to the directions of inquiry that emerged and make additions to the interview protocol as well as identify particular types of individuals we were interested in contacting. In total, we conducted 20 interivews with students from diverse majors, ethnic and racial background, immigration status, age, gender, STEM identity, and informal learning experiences

*Slide 17*
Our first step in analysis was to code the interviews. We began developing codes after our first three interviews that were based on identity literature, particularly our theoretical framework, and the interviews themselves. We initially coded these first three interviews separately and discussed our code selection. These conversations led to development of an initial team codebook that we used to code the three interviews again and check code consistency. Additionally, we began writing coding memos to reflect on our thinking to bring to team meetings to discuss coding decisions. This team coding process continued until we reached high (over 90%) coding agreement.

*Slide 18*
This slide demonstrates our coding process, which we broke up into four "tiers." The first tier is our emergent thematic codes which were derived from the interviews themselves and the relevant literature. Tiers 2, 3, and 4 were applied to indicate the person involved with the conversation, the place where the conversation took place, and the topic of the conversation, respectively. This slide shows some examples of codes within each tier.

*Slide 19*
After our coding, we reviewed excerpts for the codes and discussed their meaning as a team to generate our themes. Though we noted several interesting themes from our qualitative data, we will highlight two here. First, we found that spontaneous opportunities to talk about STEM were important in shaping STEM identity. For instance, the quotes here from Sandra and Selena (pseudonyms) suggest that opportunities to do and talk about STEM were available to the students in our interview. In Sandra's quote, she brings up STEM based on another conversation that arose by watching the news with her dad. In Selena's quote, the persistent messaging she received from her parents about her competence in dealing with computers helped her to feel comfortable entering a computer science field.

*Slide 20*
Another important theme was the frequency at which we noted that school experiences limited students' identification with STEM. Carla recalled being overlooked for an advanced math opportunity, which she discussed made her feel less competent and interested in STEM, an attitude that persisted until college. Nicki recalled that her teachers would ignore her questions, though she continued to be interested in STEM because she enjoyed watching STEM television such as Bill Nye. Though her STEM identity was not as impacted as Carla's, the lack of support she felt from her teacher is alarming, particularly for someone who often expressed a strong interest in STEM. We do note that not all of the individuals we interviewed discussed having a negative school experience with science that was as extreme as either Carla or Nicki's, but school science was often recalled as boring or simply immemorable.

*Slide 21*
Examining the results of our qualitative and quantitative data guided us to making some general conclusions about the influence of childhood science talk on STEM identity.

*Slide 22*
First, families do have a significant role in supporting their children's identification with STEM. The qualitative finding that these interactions occur spontaneously about the material that is available through normal household interactions, such as watching the news or trying to get a computer to work, highlights that parents themselves do not need to have a background in STEM to encourage their students' interest or to feel like they can have careers in STEM. Viewed in light of our quantitative data that did not see an influence of other informal STEM activities on identity, this suggests that lack of access to higher-cost STEM promoting options does not necessarily mean that students are restricted in their potential in STEM. Second, The finding about the neutral or negative school interactions suggests that these experiences do not necessarily restrict STEM identity, but it should be recalled that we interviewed students who "made it"—who have enrolled in STEM fields. These occurrences could be damaging enough to the STEM identity of many students that they turn away from STEM or simply never think to pursue it. Particularly, our interviewees had friends and family who could supplement this lack of recognition that came from the schools. Thus, some form of recognition appears to be necessary, a finding consistent with the STEM identity framework that guided our study. Additional work that considers the role of teacher and family recognition in non-STEM students would be valuable in helping to understand this phenomena.

*Slide 23*
Thank you for viewing our presentation. If you have any questions or feedback, please feel free to contact us. We would also like to acknowledge the undergraduate researchers who made valuable contributions to this work:

Alexandra Martinez (URA)
Sheila Castro (URA)
Elizabeth Palma-D'Souza (URA)
Valentina Espinosa (URA)

*Slide 24*
*[References]*