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Is it still science if you don’t call it ‘science’?
Discovery orientation and science identity among middle school youth.

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Abstract for DBER Group Discussion on 2015-02-26

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Title:
Is it still science if you don’t call it ‘science’? Discovery orientation and science identity among middle school youth.

Abstract:
To investigate the role of friendships in science identity formation, we are conducting a longitudinal survey of 441 students in an ethnically diverse Title I Middle School. This research-based approach, framed within a sociological conceptual model, will provide depth in our understanding of how to motivate and engage youth from groups underrepresented in biomedical science, and will contribute to the sociological literature on identity formation. Science educators assume most youth have a natural propensity toward science and inquiry, and will engage with science activities and ideas if they are presented in fun and appealing ways. We call this natural propensity “discovery orientation.” We have designed and piloted a measure of “discovery orientation” by asking about science propensities without using the word “science.” The label science in our culture is imbued with stereotypes, mostly as “white” and “male”. By not using the word science in survey questions and by separately measuring explicit science identity, we are able to investigate whether labeling science makes a difference in youths’ identification as a science kind of person. Preliminary findings indicate that although discovery orientation does not vary by race or gender, science identity does. White boys have higher science identity than minority boys, minority girls and white girls. Minority boys and girls also have significantly lower science enjoyment and science competence than white boys. Minority boys and girls, and white girls are less likely to say that others see them as a ‘science kind of person’. Using structural equation modeling, we explore multiple pathways to science identity.
IS IT STILL SCIENCE IF YOU DON’T CALL IT ‘SCIENCE’?

DISCOVERY ORIENTATION AND SCIENCE IDENTITY AMONG MIDDLE SCHOOL YOUTH

Trish Wonch Hill & Julia McQuillan
Department of Sociology
The STEM Pipeline is Leaking Badly

Approximately, 4 million 9th graders entered high school in 2001... Four years later, 2.8 million of them graduated and 1.9 million then went to either two- or four-year colleges; however, only 1.3 million were actually prepared for college. Less than 300,000 majored in STEM fields and only about half graduated college with a STEM degree by 2011.

For African-Americans the STEM yield is ~1-2%; we need to increase the yield 10X!

Source: NCES Digest of Education Statistics; Science & Engineering Indicators 2008
Background

Study of 800 9th and 10th graders – student randomly assigned to an essay about a virus or a ‘World of Viruses’ comic to assess whether students would be engaged with the materials and have more knowledge about viruses (Spiegel, et al., 2013).
Latent class analysis showed that youth with lower science identity were as engaged with comics as youth with high science identity. Knowledge gained from the comics was the same for both groups.
Science Identity Should Matter

• Youth with higher science identities are more engaged with science and more likely to persist in STEM careers (May & Chubin, 2003; Carlone & Johson, 2007; Chemers, et al., 2011; Spiegel, et al., 2013).
The Scientist in the Crib

• All humans have curiosity, a capacity to learn about the world through trial and error, and a tendency to develop theories about how the world works.

• An array of research studies with infants and toddlers have shown that, in fact, children have sophisticated methods that can be compared with those used by scientists (Gopnik, Meltzoff, & Kuhl, 1999).

This idea, that everyone is born a scientist, is counter to pervasive stereotypes that only some (usually men) are born with “genius” abilities to excel in particular science fields (e.g. Physics) (Leslie et al., 2015).
Identity Theory

Most Salient Identity

(Across situations, easily activated, most aware of)

Next salient identity

Least salient identity

Commitment increases with salience
Identity Theory

Types of Identities (Burke & Stets, 2009)
Social Identities/Social Structures

• Science identities might be particularly difficult to maintain if they conflict with other more salient identities (race or gender).

• From a Sociological Identity Theory perspective, the implicit associations attached to science kind of person (e.g. white, male), social interactions (e.g. significant others and peers treating one or labeling one as a science kind of person or not) also contribute to developing a science identity or not.
Self-Verification

• Self-identifying as a science kind of person, or claiming to be a “science kind of person” occurs in interaction with others and is informed by images of scientists in popular cultures, text books, and news media (Newton and Newton, 2008).

• Science identity should depend on not only one’s own actions, but also by how those actions are recognized and acknowledged by others.

• Implicit Biases/Stereotype Threat
Looking Glass Self

The Looking Glass Self

How my mom and dad see me.
How my girlfriend sees me.
How my older brother sees me.
How my ex-girlfriend sees me.
Generalized Other

The “I” and the “Me”

The “I”

The “Me”

The “Generalized Other”

Copernicus Consulting
Afterschool Alliance – Key Components to Science Identity

• “I like it” – Affect/Enjoyment

• “I’m good at it” – Achievement/Competence

• “It’s Important” – Salience/Relevance, I use it to make decisions that affect me.

Questions we answer:

• Do “Science Identities” exist at the Middle School level?

• Do science identities differ by race and gender? If so, how?

• Do implicit assumptions about gender & science influence explicit labeling of science identities for boys and girls, or white and minority students, differently?
Discovery Orientation

1. How much do you like taking things apart to learn more about them?

2. How much do you like learning about new discoveries?

3. How curious are you about the world?

4. How much do you like learning about how the human body works?

5. How much do you like exploring nature?
Science Enjoyment/Competence

Science Enjoyment ‘I like it’
1. How much do you like science?
2. How boring are science classes for you?
2. How much would you like to join a new after school science club?

Science Competence ‘I’m good at it’
1. How good are you at science?
2. How well do you usually do in science classes?
3. What grades do you usually get in science classes?
Identity Variables

Science Salience “It’s Important”
1. How often do you use science to solve daily problems?
2. How much does science help you make decisions that affect your body?
3. How much, if at all, does science help people?
4. How much, if any, do you think studying science will help you in the future?

Science Self-Verification
1. How much do you teachers make you feel like you are good at science?
2. How much do you parents tell you that you are good at science?
Identity Variables

Generalized Other
1. How much do other people think you are a science kind of person?

Science Identity
1. How much do you think you are a science kind of person?
2. How much, if at all, do you want to become a scientist?
3. What kind of job do you want as an adult? (A job with a lot of science -> A job with no science at all.)
The Context

A Title I Middle School in a Midsized Midwestern City

Wave I Survey – N=441 participants

6th, 7th and 8th graders in a Science Classroom

63% Minority Students
Descriptive Statistics by Race/Gender

Figure 1. Science Identity by Gender and Race
N=441

- White Boys (N=80)
- Minority Boys (N=129)
- White Girls (N=78)
- Minority Girls (N=148)
Correlations among Science Identity Dimensions, Midwest Middle School Youth, N = 441

<table>
<thead>
<tr>
<th></th>
<th>Science Identity</th>
<th>Discovery Orientation</th>
<th>Science Competence</th>
<th>Science Relevance</th>
<th>Science Enjoyment</th>
<th>Self Verification</th>
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<td>.32***</td>
<td>.35***</td>
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</tbody>
</table>

Table 1. Bivariate Correlation Matrix (N=441)
Structural Equation Model N=441

Model Fit
- Estimation: MLR
- Chi-Squared: 350.639***
- CFI: .95
- TLI: .93
- RMSEA: .04
- SRMR: .04
- R-Squared
  - Science Identity: .86
  - Enjoyment: .72
  - Salience: .43
  - Competence: .23
  - Self-Verification: .23

Correlations
- Enjoyment <-> Competency: .50 ***
- Enjoyment <-> Salience: .37 *
- Enjoyment <-> Self-Verification: .52 ***
- Competency <-> Salience: .09
- Competency <-> Generalized Other: .31 ***
- Competency <-> Self-Verification: .49 ***
- Competency <-> Generalized Other: .17 **
- Salience <-> Self-Verification: .31 ***
- Salience <-> Generalized Other: .17 **
- Self-Verification <-> Generalized Other: .27 ***

**Note:** The diagram shows relationships between variables such as Discovery Orientation, Science Enjoyment, Science Salience, Science Competence, and Science Verification, among others, with correlations and model fit statistics provided.
Structural Equation Model N=441

Discovery Orientation -> Science Enjoyment: 0.84

Science Enjoyment -> Science Identity: 0.81

Science Salience -> Science Identity: 0.42

Science Competence -> Science Identity: 0.63

Science Verification -> Science Identity: 0.37

Generalized Other – Do other people think you are a science kind of person?

- Science Competence
- Science Salience
- Science Enjoyment
- Science Verification

Science Identity: Self-label & Commitment

N=441
## Structural Equation Model N=441 Direct

![Diagram](Image)

### Correlations

<table>
<thead>
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<th>Correlation</th>
<th>Value</th>
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<td>Enjoyment &lt;-&gt; Competency</td>
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<td>Enjoyment &lt;-&gt; Salience</td>
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</tr>
</tbody>
</table>

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*Correlation significance levels: *** p < .001, ** p < .01, * p < .05*
Structural Equation Model N=441 Direct

- White Boys
- Minority Boys
- White Girls
- Minority Girls

Science Enjoyment
Science Salience
Science Competence
Science Verification

Science Identity Self-label & Commitment

Generalized Other – Do other people think you are a science kind of person?

Variables and Paths:
- White Boys to Science Enjoyment: -.14
- Minority Boys to Science Enjoyment: -.22
- White Boys to Science Salience: -.23
- Minority Boys to Science Salience: -.15
- White Boys to Science Competence: -.14
- Minority Boys to Science Competence: -.17
- White Boys to Science Verification: -.20
- Minority Boys to Science Verification: -.19
- Science Enjoyment to Science Identity: .31
- Science Salience to Science Identity: .42
Structural Equation Model N=441 Indirect

Discovery Orientation → Science Enjoyment
Discovery Orientation → Science Salience
Discovery Orientation → Science Competence
Discovery Orientation → Science Verification

Science Identity
Self-label & Commitment

White Boys
Minority Boys
White Girls
Minority Girls

-0.17
-0.04
-0.06
-0.06

Generalized Other – Do other people think you are a science kind of person?
Structural Equation Model N=441 Direct

Model Fit
- Estimation: MLR
- Chi-Squared: 350.639***
- CFI: .95
- TLI: .93
- RMSEA: .04
- SRMR: .04

Correlations
- Enjoyment <-> Competency: .50 ***
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- Salience <-> Generalized Other: .17 **
- Self-Verification <-> Generalized Other: .27 ***
Future Research

• Go beyond “reflexive role taking” reports of what you think that others think and use reports from friends

• Social Network Analysis
  Do middle school youth tend to select friends with similar levels of science identity, and/or do friends influence the science identities of their friends?

ASSESS:
  Social selection (science identity homophily - or science kinds of kids becoming friends with each other)
  or
  Socialization by friends to have a science identity
Indirect
References


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Thank you!

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