Gender and STEM: Self and Agentic Action

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Gender and STEM
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I began my research work on gender and motivation with a quite specific question posed by the National Institute of Education in 1977:

**WHY ARE FEMALES LESS LIKELY TO GO INTO MATH AND PHYSICAL SCIENCE THAN MALES?**
WHY DOES ANYONE DO ANYTHING?

My colleagues and I developed a theoretical framework to guide our research on both of these questions —

- a framework grounded in both psychological and socio-cultural perspectives
- a framework that sought to incorporate both personal agency and structure
Two Aspects of Choosing One’s Life Path

**Personal Agency = Picking One’s Path**
- Expectancy-value models of rational choice
- Identity development

**Structural Forces = Opportunities and Barriers to Picking One’s Own Path**
- Social forces that shape and restrict one’s choices
Developing a Theory to Explain Gender and Achievement-Related Choices

- My colleagues used these two perspectives to develop a theoretical framework to guide a research program on the question posed by NIE.

- WHY ARE FEMALES LESS LIKELY THAN MALES TO GO INTO THE PHYSICAL AND ENGINEERING SCIENCES?
Common Explanations

- **Biological Differences**
  - **Brain differences** –
    - Hemispheric Specialization
      - May be linked to verbal and spatial skills
    - Specialized Sensitivities for Learning and Interests
      - Such as preferences for speech input and faces versus mechanical objects
      - Do not know the actual mechanisms but genetic studies suggest these may be heritable and may be sex-liked
  - **Disabilities**
    - Learning particular types of materials
    - Social intelligence
    - Anxieties
Social Experiences

- **Family and Peers**
  - Role Models
  - Expectations
  - Provision of Differential Experiences

- **Schools and Larger Society**
  - Differential Treatment
  - Discrimination
  - Differential Teaching Practices for Different Subject Areas
Psychological Differences

- Ability Self Concepts for Different Skill Areas
- Domain Specific Interests and Preferences
- More General Differences in Values and Goals
- Anxieties
- Susceptibility to Stereotype Threat
- Implicit Self Concepts and Stereotypes
- Theories of Intelligence
- Personal and Social Identities
- Expectations of Differential Treatment
Very Difficult to Distinguish These Hypotheses

All are Likely Influences

In addition, People Self-Socialize into the Culturally Approved Social Roles and Niches
So my colleagues and I wanted to create a comprehensive model to guide our research into the wide range of possible influences on such critical life defining choices as one’s occupation.
Eccles et al. General Expectancy Value Model of Achievement Choices:

A. Cultural Milieu
1. Gender role stereotypes
2. Cultural stereotypes of subject matter and occupational characteristics
3. Family Demographics

B. Socializer's Beliefs and Behaviors

C. Stable Child Characteristics
1. Aptitudes of child and sibs
2. Child gender
3. Birth order

D. Previous Achievement-Related Experiences

E. Child's Perception of...
1. Socializer's beliefs, expectations, attitudes, and behaviors
2. Gender roles
3. Activity stereotypes and task demands

F. Child's Interpretations of Experience

G. Child's Goals and General Self-Schemata
1. Personal and social identities
2. Possible and future selves
3. Self-concept of one's general/other abilities
4. Short-term goals
5. Long-term goals

H. Child's Affective Reactions and Memories

I. Activity Specific Ability Self Concept and Expectations for Success

J. Subjective Task Value
1. Interest-enjoyment value
2. Utility Value
3. Attainment value
4. Relative cost
5. Prior Investments

K. Achievement-Related Choices, Engagement and Persistence

Across Time
Self and Identity

- Today I am going to focus primarily on the most proximal psychological processes because these processes are directly linked to the self and to identity.

- Focus most on the components of subjective task value.
Subjective Task Value: Cost

- **Psychological Costs**
  - Fear of Success/Failure
  - Anticipated Anxiety

- **Financial Costs**
  - Lost Opportunities to Fulfill Other Goals or to do Other Activities

- **Social and Psychological Costs of Punishment or Rejection and of Violating Norms**
Key Features of Model

1. Focuses on **Choice** not on **Deficits**

2. Points Out Importance of Studying the Origins of Individuals’ Perception of the Range of Possible Options
Key Features of Model

1. Focuses on the Fact that Choices are made from a Wide Range of Positive Options

2. Focuses on the Hierarchical Nature of Both Expectancies and Subjective Task Values

3. These Hierarchies are Labile, Being Influenced by Immediate Social Context, and Developmental Tasks
How Does This Relate To Gender?
“O.K., you be the doctor, and I’ll be the Secretary of Health and Human Services.”
Personal Experiences

Subcultural Scripts, Beliefs, and Stereotypes

Social Identities

Perception of Barriers and Expected Behaviors Due to One’s Group Membership

Other Aspects of Content

Salience

Expectancies

Life Choices

Subjective Task Value
Gender and Ability Self Concepts and Personal Expectations

- Cultural Stereotypes about Which Gender is Supposed to be Good at Which Skills

- Extensive Socialization Pressures to Make Sure These Stereotypes are Fulfilled
Gender-Roles and Subjective Task Value

1. **Different Hierarchies of Core Personal Values**
   a) Concern with Social Goals versus Concern with Power or Achievement Goals;
   b) Concern with Social Relationships versus concern with Individual Achievement and Status.
   c) Interest in Things versus Interest in People.
   d) Interest in Cooperation versus Interest in Competition

2. **Density of Hierarchy**
   a) Single-mindedness versus Diverse Interests

3. **Different Long Range Goals**

4. **Different Definitions of Success in Various Goals and Roles**
   a) What does it take to be a successful father versus a successful mother?
   b) What does it take to be a successful professional?
   c) What does it take to be a successful human being?
Gendered Achievement-Related Choices: STEM

- My colleagues and I then used this framework to design a longitudinal study of gendered educational and occupational choices related to the mathematical, physical and engineering sciences.

- I have time to give you only a couple of examples of this work.
Michigan Study of Adolescent Life Transitions (MSALT)

Waves 1-4
Jacque Eccles
Carol Midgley
Allan Wigfield
Jan Jacobs
Connie Flanagan
Harriet Feldlaufer
David Reuman
Doug MacIver
Dave Klingel
Doris Yee
Christy Miller Buchanan

Waves 5-8
Jacque Eccles
Bonnie Barber
Lisa Colarossi
Deborah Jozefowicz
Pam Frome
Sarah Lord
Mina Vida
Robert Roeser
Laurie Meschke
OVERVIEW OF DESIGN AND SAMPLE:
MICHIGAN STUDY OF ADOLESCENT LIFE TRANSITIONS – MSALT

DESIGN: On-going Longitudinal Study of One Birth Cohort
Data Collected in Grades 6, 7, 10, 12; and again at Ages 20 and 25
Data Collected from Adolescents, Parents, and School – Most Using Survey Forms

SAMPLE: Nine School Districts
Approximately 1,200 Adolescents
Approximately 90% White
Approximately 51% Female
Working/Middle Class Background
<table>
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<tr>
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<td>96</td>
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</table>
MSALT Sample General Characteristics

- School based sample drawn from 10 school districts in the small city communities surrounding Detroit.

- Predominantly White, working and middle class families

- Approximately 50% of sample of youth went on to some form of tertiary education
Two Basic Initial Questions

ARE THERE GENDER DIFFERENCES ON THESE SELF AND TASK BELIEFS?

DO THE GENDER DIFFERENCES IN THESE SELF-RELATED BELIEFS MEDIATE THE GENDER DIFFERENCES IN INVOLVEMENT?
Gender Differences in Ability Self Concepts – 7th Grade

- Math
- English
- Sports

Girls

Boys

Bar chart showing differences between girls and boys in math, English, and sports ability concepts.
Gender Differences in Subjective Task Value – 7th Grade
Conclusions

- Gender Differences Occur across Several Domains for Both Ability Self Concepts and Subjective Task Values

- Gender Differences Emerge Quite Young

- But Do These Differences Mediate Gender Differences in Course Taking and Activity Involvement?
Predicting Number of Honors Math Classes (sex, DAT)  
N = 223 (honors students)  

Number of Honors Math Courses  
(R² = .08)  

Gender  
.15  

Math Aptitude  
.22
Predicting Number of Honors Math Classes
N = 223 (honors students)

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<th>Variable</th>
<th>Coefficient</th>
<th>R²</th>
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<tr>
<td>Math Aptitude</td>
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<tr>
<td>Self-Concept of Ability in Math</td>
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<tr>
<td>Interest in Math</td>
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<td>Utility of Math</td>
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<tr>
<td>Number of Honors Math Courses</td>
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Predicting Physical Science Class Enrollments

Gender

Math Aptitude

Number of Physical Science Courses

(R² = .15)

.16

.34

Number of Physical Science Courses

(R² = .15)
Predicting # of Physical Science Classes (sex, DAT)

Gender

Self Concept of PS Ability

Liking PS

Perceived Utility of PS

Number of Physical Science Courses

(R² = .34)

Math Aptitude

Gender

.16

.13

.09

.17

.09

.19

.48

.20

.09

.09

.09

.48

.20

.09
Conclusion

- In this sample, the gender differences in utility value were the strongest mediators of gender differences in math and physical science course enrollments.

- A slightly different pattern is emerging for math in the CAB study: Math Ability Self Concept is having a stronger effect.

- In this sample, the gender differences in all three expectancy–value beliefs mediated the gender differences in involvement in sports.
What about College Course Choices?
# MSALT DESIGN

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Specific Sample Characteristics for Analyses Reported Today

- Those who participated at Wave 8 (age 25)
  - Female N = 791       Male N = 575

- Those who completed a college degree by Wave 8
  - Female N = 515       Male N = 377
Sex Differences in College Majors

![Bar chart showing sex differences in college majors across Math/Science, Biology, Business, and Social Science.](chart.png)
Sex Differences in Occupations

Occupation at Age 25 by Sex

- Math/Science
- Biology
- Business

Frequency

Female
Male
Analyses 1: Between Sex

- Logistic regression to test for mediators of sex differences in college Math/Engineering/Physical Science majors
Time 1 Measures: 12th Grade

- Math/Physical Science Self-Concept of Ability
- Math/PS Value and Usefulness
- Biology Self-Concept of Ability
- Biology Value and Usefulness
- English Self-Concept of Ability
- English Value and Usefulness
- High School Grade Point Average
Sex Differences in Domain Specific Self Concepts and Values

Self Concept and Value at Age 18 by Sex

- Math/Sci Value
- Math/Sci Self Concept
- Biology Self Concept
- Biology Value
- English Self Concept
- English Value
- Final GPA

Female
Male
Time 1 Predictors of Physical Science and Engineering College Major
Time 1 Predictors of Science College Major
Analyses: Within Sex

Discriminant Function Analyses

- Use age 20 General Ability SCs and Occupational Values to predict College Major at age 25
Domain Specific
Attractors: Self
Concepts and Values

Non-Domain
Attractors: General
Achievement

+ Academic Choice

+
Domain Specific Attractors: Self Concepts and Values

Domain Specific Detractors: Specific Costs

Non-Domain Detractors: Other Values and Self Concepts

Non-Domain Attractors: General Achievement

Academic Choice

+ -
Time 2 Measures: Age 20
Ability-Related

- Math/Science General Ability Self Concept
  - Efficacy for jobs requiring math/science
- Intellectual Ability Self Concept
  - Relative ability in logical and analytical thinking
- High School Grade Point Average
Time 2 Measures: Occupational Values

- Job Flexibility
  - Does not require being away from family

- Mental Challenge
  - Opportunity to be creative and learn new things

- Working with People
  - Working with others

- Autonomy
  - Own Boss
Time 2 Measures: Comfort with Job Characteristics

- **Business Orientation**: Comfort with tasks associated with being a supervisor

- **People Orientation**: Comfort working with people and children
Sex Differences in Age 20
General Self Concepts and Values

- Mean Value
- Math/Science Self Concept
- Value Flexibility
- Intellectual Self Concept
- *Value Mental Challenge
- Value Independent
- Value Working with People
- *Value Autonomy
- Business Oriented
- People Oriented
- Final GPA

Female
Male
Sex Differences in Age 20 General Self Concepts and Values

- Math/Science Self Concept
- Value Flexibility
- Intellectual Self Concept
- Value Mental Challenge
- Value Independent
- Value Working with People
- *Value Autonomy
- Business Oriented
- People Oriented
- Final GPA

Female
Male
Predicting Women’s M/E/PS and Biological Science College Major from General Self-Concepts and Values at 20
Predicting Men’s M/E/PS and Biological Science College Major from General Self-Concepts and Values at 20
Predicting M/E/PS vs. Biology Major From General Self-Concepts and Values at 20
Predicting M/E/PS vs. Social Science Major From General Self-Concepts and Values at 20
Conclusions 1:

- Strong support for the predictive power of constructs linked to the Expectancy Value Model.
  - Domain Specific SCs and Values push both women and men towards the related majors
  
  - Some evidence that more general values can also push people away from M/S/PS majors and towards Biology-Related majors

- Sex differences in selection of M/E/PS college major are largely accounted for by Expectancy Value Model
Conclusions 2

- Even stronger support for both the push and pull aspects of the Eccles et al. Expectancy Value Model

- Strong evidence that valuing having a job that allows one to work with and for people pushes individuals away from M/E/PS majors and pulls them toward the Biological Sciences
Applications

- Interventions to increase the participation of females in M/E/PS need to focus on increasing women’s understanding that M/E/PS and Informational Technology jobs can help people and do involve working with people as well as increasing their confidence in their ability to succeed in these fields.
What have I Left Out?

- Critical roles of parents and teachers
  - We have this information on this in this sample and another sample.
  - Both are key in shaping gender differences in all aspects of this model.
  - On average, these processes reinforce traditional gender role self images and choices.
What have I Left Out?

- The other psychological and social processes that drive women and men out of non-traditional fields

- I am particularly interested in the processes that influence interest in and intense passion for particular activities.

- The role that ongoing emotional experiences play in shaping more stable and enduring interests, “passions”, and thus the differential Subjective Task Value of various activities.
The End

Thank You

More details and copies can be found at
www.rcgd.isr.umich.edu/garp/