Predicting Mathematics-Related Educational and Career Choices

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Participation in M/S/E careers

- In 1997, women represented
  - 23% of all scientists and engineers
  - 63% of psychologists
  - 42% of biologists
  - 10% of physicists/astronomers
  - 9% of engineers

Source: National Science Foundation, 2000
Bachelors’ degrees in 2000

<table>
<thead>
<tr>
<th>Subject</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total M/S/E</td>
<td>28.0</td>
<td>36.9</td>
</tr>
<tr>
<td>Physical</td>
<td>0.8</td>
<td>1.6</td>
</tr>
<tr>
<td>Engineering</td>
<td>1.7</td>
<td>8.8</td>
</tr>
<tr>
<td>Math/CS</td>
<td>2.2</td>
<td>6.2</td>
</tr>
<tr>
<td>Earth</td>
<td>0.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Biological</td>
<td>6.5</td>
<td>6.8</td>
</tr>
<tr>
<td>Social</td>
<td>8.6</td>
<td>9.7</td>
</tr>
<tr>
<td>Psychology</td>
<td>8.0</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Source: NSF 02-327
Figure 1. 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. Attainment value
3. Utility value
4. Relative cost

K. Achievement-Related Choices, Engagement and Persistence

Across Time
Basic Expectancy Value Model

- Domain-Related Ability Self Concepts/Expectations for Success → Occupational/Educational Choice (+)
- Non-Domain-Related Ability Self Concepts/Expectations for Success → Occupational/Educational Choice (−)
- Domain-Related Perceived Task Values → Occupational/Educational Choice (+)
- Non-Domain-Related Perceived Task Values → Occupational/Educational Choice (−)
Michigan Study of Adolescent/Adult Life Transitions: MSALT

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Time 1</th>
<th>Time 2</th>
<th>Time 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRADE</td>
<td>6th</td>
<td>6th</td>
<td>7th</td>
</tr>
<tr>
<td>WAVE</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>YOUTH SURVEY</td>
<td>●●●●</td>
<td>●●●●</td>
<td>●●●●</td>
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<tr>
<td>PARENTS SURVEY</td>
<td>●●●●</td>
<td>●●●●</td>
<td></td>
</tr>
<tr>
<td>TEACHER QUESTIONNAIRE</td>
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<td>●●●●</td>
<td>●●●●</td>
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<tr>
<td>RECORD DATA</td>
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<td></td>
</tr>
<tr>
<td>FACE TO FACE INTERVIEW</td>
<td></td>
<td></td>
<td>●+</td>
</tr>
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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
- Downsizing of automobile industry caused major economic problems while the youth were in secondary school
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
Predicting # of Honors Math Classes

Gender

Self-Concept Of Ability In Math (R² = .06)

Interest In Math (R² = .02)

Number of Honors Math Courses (R² = .19)

Math Aptitude

Utility of Math (R² = .04)
Predicting # of Physical Science Classes (sex, DAT)

Number of Physical Science Courses ($R^2 = .15$)

- Gender
- Math Aptitude

Correlations:
- Gender: .16
- Math Aptitude: .34
Predicting # of Physics Classes

- Gender
  - Utility of P.S. (R^2 = 0.05)
  - Number of Physical Sciences Courses (R^2 = 0.34)
- Math Aptitude
  - Number of Physical Sciences Courses (R^2 = 0.34)
- Self-Concept of Ability in P.S. (R^2 = 0.06)
  - Utility of P.S. (R^2 = 0.05)
  - Number of Physical Sciences Courses (R^2 = 0.34)
- Linking P.S. (R^2 = 0.03)
New Analyses: Within Sex Discriminant Function Analyses

- Use 12\textsuperscript{th} grade Domain Specific Ability SCs and Values to predict College Major at age 25

- Use age 20 General Ability SCs and Occupational Values to predict College Major at age 25
New Analyses 2: Between Sex

- Logistic regression to test for mediators of sex differences in college Math/Engineering/Physical Science majors
New Within-Sex Discriminant Function Analyses: Part 3

- Use 12th grade Domain Specific Ability SCs and Values to predict Occupations at age 25

- Use age 20 General Ability SCs and Occupational Values to predict Occupations at age 25
Time 1 Measures

- 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

<table>
<thead>
<tr>
<th>Subject</th>
<th>Mean Value</th>
</tr>
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<tbody>
<tr>
<td>Math/Sci Value</td>
<td>5.5</td>
</tr>
<tr>
<td>Math/Sci Self Concept</td>
<td>5.0</td>
</tr>
<tr>
<td>Biology Self Concept</td>
<td>4.5</td>
</tr>
<tr>
<td>Biology Value</td>
<td>4.0</td>
</tr>
<tr>
<td>English Self Concept</td>
<td>3.5</td>
</tr>
<tr>
<td>English Value</td>
<td>3.0</td>
</tr>
<tr>
<td>Final GPA</td>
<td>2.5</td>
</tr>
</tbody>
</table>

- **Female**
- **Male**
Time 2 Measures: 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 General Self Concepts and Values

![Bar chart showing mean values for different self-concepts and values for female and male students.](chart.png)
Time 3 Measures

- Final College Major

Occupation at Age 25: Coded into Global Categories based on Census Classification Criteria
Sex Differences in College Majors

![Bar chart showing frequency of different majors for females and males. Math/Science and Biology are dominated by females, while Business and Social Science are more balanced.]
Sex Proportions in College Majors

College Major by Sex

- **Math/Science**
  - Female: 50%
  - Male: 50%

- **Biology**
  - Female: 90%
  - Male: 10%

- **Social Science**
  - Female: 50%
  - Male: 50%

- **Business**
  - Female: 50%
  - Male: 50%
Sex Differences in Occupations

Occupation at Age 25 by Sex

- Math/Science
- Biology
- Business

Frequency

- Female
- Male
Sex Proportions in Occupations at 25

Participant's Occupation at Age 25 by Sex

Percentage

Math/Science
Biology
Business

Female
Male

0 10 20 30 40 50 60 70 80 90

Sex Proportions in Occupations at 25
Predicting Women’s Math/Engineering/Physical Science (M/E/PS) and Biological Science College Major from Domain Specific SCs and Values at 18
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 Domain Specific SCs and Values at 18
Predicting Men’s M/E/PS and Biological Science College Major from General Self-Concepts and Values at 20

Graphs showing discriminant function coefficients for predicting Math/Science vs. Other College Major and Biology vs. Other College Major.
Mediation of Sex Differences

- Used logistic regression to assess the extent to which the Time 1 and Time 2 predictors explained the sex difference in majoring in Math/Engineering/Physical Science
- Step 1: Sex only
- Step 2: Sex plus all of Time 1 or Time predictors
Time 1 Predictors of Science College Major

- Final GPA
- Math SC
- Math Value
- Gender 2
- Gender 1

Coefficient B
Time 2 Predictors of Science College Major

- Final GPA
- Math/SC
- Gender
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 accounted for by Expectancy Value Model
Next Step

- Do Within Sex Discriminant Function Analysis comparing Choice of Math/Science Major with Specific Alternative Major
Predicting M/E/PS vs. Biology Major From Domain Specific SCs and Values at 18
Predicting M/E/PS vs. Biology Major From General Self-Concepts and Values at 20
Predicting M/E/PS vs. Social Science Major From Self-Concepts and Values at 18
Predicting M/E/PS vs. Social Science Major From General Self-Concepts and Values at 20
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
New Analyses 3

Now let's shift to the second set of analyses: those linking self concepts and values from ages 18 and 20 to actual occupations at age 25
Predicting M/E/PS vs Biology Occupations at 25 from Self Concepts and Values at 18
Predicting M/E/PS vs Biology Occupation at 25 from General Self Concepts and Values at 20

Discriminant Function Coefficient for Females

- Final GPA
- Value Flexibility
- Value Math/Sci
- Value Working with People
- People Oriented

Discriminant Function Coefficient for Males

- Value Autonomy
- Value Working with People
Predicting M/E/PS vs Business Occupations at 25 From Self Concepts and Values at 18
Predicting M/E/PS vs Business Occupation at 25 from General Self Concepts and Values at 20

Discriminant Function Coefficient for Females

- Value Flexibility
- Value Mental Challenge
- Value Working with People
- Intellectual Self Concept
- Math/Sci Value

Discriminant Function Coefficient for Males

- People Oriented
- Intellectual Self Concept
- Value Working People
- Value flexibility
- Math/Sci Self Concept
- Final GPA
Expectancy Value Model provides a good explanatory framework for understanding both individual differences and sex differences in educational and occupational choices.
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.
Thank You

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