Attitudes Matter!
New Instruments in Motivational Attitudes Toward Statistics / Data Science
MathFest 2022

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Attitudes

- Attitudes Matter in Education! (Pearl et al., 2012)

- We want students to **thrive in the data deluge**

- **Instructor attitudes** and course environment impact **student attitudes**

- Understanding attitudes can help us identify **evidence-based best practices for teaching data science and statistics**
## Existing Instruments (Examples)

### Student Instruments
- **Survey of Attitudes toward Statistics (SATS; Schau, 1992)**
  - Most widely used
- **Issues** (Whitaker, Unfried, & Bond, 2022)
  - Lack of validity evidence
  - Incomplete alignment to theoretical framework
  - Ceiling effects on some scales
  - Rigid pre-post structure
  - Requires stats course enrollment
  - Use restricted - fees/permission

### Instructor/Environment Instruments
- **Statistics Teaching Inventory (STI; Zieffler et al., 2012)**
  - Snapshot of instructor practices in Introductory Statistics
- **Issues**
  - Does not measure attitudes or learning environment characteristics
  - Not linked to student measures

**No Validated Data Science Attitudes Instruments**
MASDER:

Motivational Attitudes in Statistics and Data Science Education Research

- 3-year NSF IUSE grant (Oct ‘20 - Sept ‘23)
- Strong theoretical framework (EVT) and rigorous development process
- Family of 6 instruments evaluating student and instructor attitudes toward statistics and data science, and the learning environment
- Conduct nationally-representative sample of students and instructors
- Create website interface for each implementation and dissemination of general and instructor-specific results
- Promote Stat/DS Ed Research - improve instruction by understanding the relationships between components
### Surveys Of Motivational Attitudes toward...

<table>
<thead>
<tr>
<th></th>
<th>Student Instrument</th>
<th>Instructor Instrument</th>
<th>Environment Inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistics</td>
<td>S-SOMAS</td>
<td>I-SOMAS</td>
<td>E-SOMAS</td>
</tr>
<tr>
<td>Data Science</td>
<td>S-SOMADS</td>
<td>I-SOMADS</td>
<td>E-SOMADS</td>
</tr>
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</table>
## Distinction between S, I, and E Surveys

<table>
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<tr>
<th>Student Instruments</th>
<th>Instructor Instruments</th>
<th>Environment Inventories</th>
</tr>
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<tbody>
<tr>
<td>Measures attitudes toward Stat or DS</td>
<td>Measures instructor attitudes toward teaching Stat or DS</td>
<td>Measures institutional and course characteristics, learning environment, and enacted classroom behaviors</td>
</tr>
<tr>
<td>Pre and post (optional)</td>
<td>Measure teaching experience, background, etc.</td>
<td>Instructor completes for each section</td>
</tr>
<tr>
<td>Can be used longitudinally, including after college</td>
<td>Administered periodically</td>
<td></td>
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- **Student Instruments**
  - Measures attitudes toward Stat or DS
  - Pre and post (optional)
  - Can be used longitudinally, including after college

- **Instructor Instruments**
  - Measures instructor attitudes toward teaching Stat or DS
  - Measure teaching experience, background, etc.
  - Administered periodically

- **Environment Inventories**
  - Measures institutional and course characteristics, learning environment, and enacted classroom behaviors
  - Instructor completes for each section
Development Timeline for S-SOMAS/DS

Identify need for a new instrument
- Research On Statistics Attitudes (ROSA) working groups
- 3 workshops funded by ASA

Develop theoretical models
- Started at USCOTS workshop
- Continued refinement in consultation with experts and through survey analysis

Create Pilot 0 S-SOMAS Instrument
- Write construct definitions and develop items
- Conduct student focus groups and subject matter expert review

Administer, Analyze, and Revise Pilot 0
- 2,381 students from 6 institutions

Administer, Analyze, and Revise Pilot 1
- 588 students from 15 institutions
- SOMADS Development
- SOMADS SME Workshop

Administer, Analyze, and Revise Pilot 3
- 87 students from 4 institutions
- SOMADS Refinement

Spring 2021
- Administer, Analyze, and Revise Pilot 1
- 2,546 students from 41 institutions

Fall 2021
- Administer, Analyze, and Revise Pilot 1

Spring / Summer 2022
- Administer, Analyze Pilot 3

MASDER Grant Awarded
Meta-Model

Surveys of Motivational Attitudes toward Statistics and Data Science

Meta-Model Explaining Student Achievement in Statistics and Data Science

Environment Model

- Institutional Structures and Characteristics
- Enacted Classroom Behaviors

Instructor Motivation

Instructor Professional Activities

EVT Model for Instructors

- Student Motivation
- Student Background

Student Achievement

- Student Survey S-SOMAS S-SOMADS
- Environment Inventories E-SOMAS E-SOMADS
- Instructor Survey I-SOMAS I-SOMADS

Assessed by other instruments not in family of instruments
Student Model

Survey of Motivational Attitudes toward Statistics (SOMAS)
Survey of Motivational Attitudes toward Data Science (SOMADS)

Student Expectancy-Value Theory Model

Goals and Self-Schemata
- Minimum Standard for Achievement
- Career/Life Goals
- Goal Orientation (Intrinsic/Extrinsic)
- Academic Self-Concept

Subjective Task Value
- Interest/Enjoyment Value
- Attainment Value
- Utility Value
- Costs and Benefits

Beliefs & Stereotypes about Statistics/Data Science

Student Background, Aptitude, and Perceptions of Others’ Attitudes and Expectations

Self-Concept of Statistics/Data Science Ability

Performance Behaviors → Achievement

Perception of Difficulty

Expectancies
## Constructs and Definitions

<table>
<thead>
<tr>
<th>Construct</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expectancy</td>
<td>How the student thinks they will perform in the field of statistics</td>
</tr>
<tr>
<td>Perception of Difficulty</td>
<td>How difficult the student perceives statistics to be</td>
</tr>
<tr>
<td><strong>Utility Value</strong></td>
<td>How much the student values statistics for serving or achieving their goals.</td>
</tr>
<tr>
<td>Interest/Enjoyment Value</td>
<td>The interest a student has in statistics, or their enjoyment from it</td>
</tr>
<tr>
<td>Attainment Value</td>
<td>How important success in statistics is to the student</td>
</tr>
<tr>
<td>Costs and Benefits</td>
<td>Factors that deter from learning stats, or benefits of learning stats</td>
</tr>
<tr>
<td>Academic Self-Concept</td>
<td>Student perceptions about the academic achievement (general and stats-specific)</td>
</tr>
<tr>
<td>Goal Orientation</td>
<td>What drives the students to learn statistics</td>
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</tbody>
</table>
## Example Utility Value Items

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I need to know statistics to satisfy employers.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I will rarely use statistics in the future.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>No one in my career field uses statistics.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I value statistics because it makes me an informed citizen.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Studying statistics is pointless.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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← Negatively Coded
Instrument Design

“I’ll take 3-letter acronyms for $200, please”

Item design, SME, Pilots

7-point data, 6-factor EFA, cutoff = 0.40
Get Involved!

Serve as a Subject Matter Expert (SME)

Pilot the surveys in your classrooms and as an instructor

See more and sign up to stay updated via our website: SDSAttitudes.com

Help spread the word about the instruments and our website!
# MASDER Contact Information

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References


Mair, P., & De Leeuw, J. (2019). Gifi: Multivariate Analysis with Optimal Scaling (R package version 0.3-9) [Computer software]. https://CRAN.R-project.org/package=Gifi


