Authentic Discovery Learning Projects in Statistics
with Constructs from Environmental and Social Science Disciplines

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Teaching Mathematics and Statistics through Current Civic Issues
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Framework:
Statistics Education Research

National Science Foundation
WHERE DISCOVERIES BEGIN
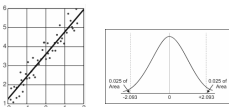
● Supported by NSF Grant: "*Authentic, Career-Specific Discovery Learning Projects in Introductory Statistics*"
● Goals: Increase students'
  – knowledge & comprehension of statistics
  – perceived usefulness of statistics
  – self-beliefs about ability to use and understand statistics

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Discovery Projects

● Linear regression
  – Variables
    ● student selects
    ● often survey based constructs
  – Survey design
  – Sampling
  – Regression analysis

● *t*-tests
  – Variables
    ● may borrow from data previously collected
  – Designs
    ● Independent samples
    ● Dependent samples
  – Hypotheses

Authentic Research Constructs

● Interdisciplinary Team
  – Biology/Ecology
  – Criminal Justice
  – Psychology
  – Sociology
  – Health Professions (Nursing, Physical Therapy)
  – Education
  – Business
● Tasks of Team Members
  – Identify quantitative research constructs
  – Define instrument/measurement of construct
  – Suggest simple statistical research projects

Constructs and Projects:
Biology/Ecology (I)

● Trash generation
  – e.g., measure by weighing trash daily for 1 week
  – Sample projects
    ● regression: trends by age?
    ● *t*-test: compare trash generated by two groups (e.g., gender, urban/rural, ecology/non-ecology majors)
● Lichen growth as indicator of air quality
  – documented instructions for measuring growth
  – Sample projects
    ● *t*-test: compare wooded areas in rural/suburban regions

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Constructs and Projects:
Biology/Ecology (II)

● Assessment of environmental risks
  – Examples: global warming, nuclear power, pesticides, burning fossil fuels, smoking, firearms
  – Participants rank risk (e.g., on a 1 – 10 scale)
    ● severity of risk
    ● degree to which risk is obvious, observable, known
    ● degree to which people have control over risk
  – Sample projects
    ● regression: relationship between any 2 of above rankings (e.g., severe vs. controllable)
    ● *t*-test: compare ratings among groups (e.g., gender, urban/rural, ecology/non-ecology majors)

Constructs and Projects: Biology/Ecology (III)

- Attitude toward environmental issues
  - Examples: importance of recycling, importance of energy conservation
  - Participants rate perceived importance (e.g., on a 1 – 10 scale)
    - single issue
    - group of issues and take average (created construct)
  - Sample projects
    - regression: relationship between any 2 ratings (e.g., attitude toward recycling vs. toward conservation)
    - *t*-tests: 1) independent – compare among groups or 2) dependent – survey before and after ecology course

Constructs and Projects: Criminal Justice

- Attitude toward criminal justice issues
  - Examples: death penalty, gun control, pornography, legalization of marijuana, legal drinking age
  - Quantitative: numeric Likert style response
  - Categorical: favor vs. oppose
  - Sample projects
    - regression: relationship between any 2 ratings (e.g., attitude toward death penalty vs. toward gun control)
    - *t*-tests: 1) compare ratings between groups (e.g., by gender) or 2) compare other attributes between favoring/opposing groups (e.g., age, other quantified attitude variable)

Constructs and Projects: Sociology (I)

- Attitude toward social issues
  - Ex: corporal punishment, homosexuality, abortion
  - Quantitative: numeric Likert style responses
  - Categorical: favor/oppose
  - Sample projects
    - regression: relationship between 2 ratings or between 1 rating and another quantitative variable (e.g., relationship between age and attitude toward corporal punishment)
    - *t*-tests: 1) compare ratings between groups (e.g., by gender) or 2) compare other attributes between favoring/opposing groups (e.g., age, other quantified attitude variable)

Constructs and Projects: Sociology (II)

- Attitude toward women
  - Multi-item questionnaire
    - Likert style responses
    - Overall numeric score
    - Sample items:
      - *A woman should not work if her husband is capable of supporting the family*
      - *Women are not suited to serve in the armed forces*
  - Sample projects
    - regression: relationship between score and another quantitative variable (e.g., age or other attitude variable)
    - *t*-tests: compare scores between groups (e.g., by gender, between 2 ethnic groups, between rural/urban)

Constructs and Projects: Sociology (III)

- Racism
  - Multi-item questionnaire
    - Likert style responses
    - Overall numeric score
    - Sample item
      - *I would be comfortable if my close relative were planning to marry someone of another race.*
  - Sample projects
    - regression: relationship between score and another quantitative variable (e.g., age or other attitude variable)
    - *t*-tests: compare scores between groups (e.g., by gender, between 2 ethnic groups, between rural/urban)

Constructs and Projects: Psychology

- Screening instruments (avoid diagnostic)
  - Construct examples
    - Perceived stress
    - Perfectionism
    - Depression
    - Alcohol abuse
    - Anxiety
    - Obsessive Compulsive (OCD)
    - Attention Deficit/Hyperactivity (ADHD)
  - Sample projects
    - regression: relationship between 2 scores (e.g., stress and perfectionism); or with another quantitative variable (e.g., age)
    - *t*-tests: compare scores between groups (e.g., by gender, between 2 ethnic groups, between rural/urban)

Pilot Study – Fall 2007

- Based on 10 sections of Introductory Stats
- 4 experimental sections
  - Used authentic discovery projects
  - n=113 participants out of 128 students
    - 88% participation rate
- 6 control sections
  - Did not use authentic discovery projects
  - n = 164 participants out of 192 students
    - 85% participation rate

Pilot Results: Content Knowledge

- Instrument
  - 21 multiple choice items
  - KR-20 analysis: score = 0.63
- Results
  - control mean: 8.87; experimental mean = 10.82
  - experimental mean 9 percentage points higher
  - experimental group significantly higher (p < .0001)
  - effect size = 0.59

Pilot Results: Perceived Usefulness of Statistics

- Instrument
  - 12-item Likert style survey; 6-point scale
  - 5 items reverse scored
  - score is average (1 – 6) of all items
  - Cronbach alpha = 0.93
- Results
  - control mean: 4.24; experimental mean = 4.51
  - experimental group significantly higher (p < .01)
  - effect size = 0.295

Pilot Results: Statistics Self-Beliefs

- Beliefs in ability to use and understand statistics
- Instrument
  - 15-item Likert style survey; 6-point scale
  - score is average (1 – 6) of all items
  - Cronbach alpha = 0.95
- Results
  - control mean: 4.70; experimental mean = 4.82
  - difference not significant (1-tailed p = .1045)
  - effect size = 0.15

Full Study (In Progress)

- 3 institutions
  - 1 university (6 undergraduate sections)
  - 1 2-year college (2 sections)
  - 1 high school (3 sections)
- 7 instructors
- Quasi-Experimental Design
  - Spring 2008: All instructors "control"
  - Fall 2008: All instructors "experimental"