Achieving Statistical Literacy in Elementary School Using Current Popular Curricula

Statistics Education in the US

- 1989 NCTM put forth recommendations for school mathematics curriculum in "Curriculum and Evaluation Standards for School Mathematics"
  - Included a "Data Analysis and Probability" strand
- 1990s NSF supported the development of curricula to align with the NCTM recommendations
  - 1996 funded "Investigations in Number, Data, and Space"
  - 1996 funded "Math Trailblazers"
  - Early 1990s funded "Everyday Mathematics"
- 2001 Conference Board of Mathematical Sciences (CBMS) issued "The Mathematical Education of Teachers"
  - Included recommendations for the development of teacher understanding of "Data Analysis, Statistics, and Probability"
- 2005 ASA endorsed the "Guidelines for Assessment and Instruction in Statistics Education: a Pre-K-12 Curriculum Framework" (GAISE) report

NSF Funded Elementary School Curricula

- Investigations
  - TERC in Cambridge Massachusetts
  - K-5th grade
  - Strands: Data Analysis and Probability
  - Uses data to develop concepts
- Trailblazers
  - Teaching Integrated Mathematics and Science (TIMS) project
  - University of Illinois
  - K-5th grade
  - Strands: Data Collection, Averages, Estimation, Accuracy, and Error, the TIMS laboratory method
  - Integrates science with mathematics
- Everyday Mathematics
  - Center for Elementary Mathematics and Science Education at the University of Chicago
  - Pre-K-6th grade
  - Strands: Data and Chance
  - Uses manipulatives and interactive activities

GAISE Report

- Pre-K-12 education should aim to graduate statistically literate population
- A statistically literate person is one who can:
  - Formulate questions
  - Collect data
  - Analyze data
  - Interpret results
- There are 3 different levels of statistical literacy (levels A, B, and C)
- The difference among levels lie in the sophistication of the methods used in the four components above
- Framework identifies the difference between mathematics and statistics
  - Variability
  - Context
  - Use of probability

Ingredients needed to achieve statistically literate population

- Curriculum
- Statistically literate teachers

Research Questions

- Do the NSF funded curricula provide the tools and guidance needed for students to achieve statistical literacy at each level?
- How well do these curricula line up with the framework put forth in the GAISE report?
- What levels of the GAISE report do the curricula achieve?
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**Methods**
- Compare lowest grade common to all the curricula to GAISE report: kindergarten
- Compare highest grade common to all the curricula to GAISE report: fifth grade
- Approach—see where they start and where they end
- Answer the following questions:
  - What GAISE Level is covered?
  - Is the concept of variability introduced?
  - Is statistics introduced using context?
  - Is the role of probability in statistics explicitly explained?
  - Is the curriculum aligned with the GAISE framework?

**GAISE Level A Components**
- **Formulate Questions**
  - Teachers help student pose questions
  - Students distinguish between statistical solution and fixed answer
- **Collect Data to Answer Questions**
  - Classroom Census
  - Individual-to-individual variability
  - Compare group to group
  - Idea of distribution
  - Describe distribution
  - Observe association between variables
- **Analyze Data**
  - Compare individuals
  - Compare individual to group
  - Compare group to group
  - Idea of distribution
- **Interpret Results**
  - Inference to classroom
  - Acknowledge results may differ with another class
  - Recognize limitation of scope of inference to classroom

**Kindergarten Results**

<table>
<thead>
<tr>
<th></th>
<th>Investigations</th>
<th>Everyday</th>
<th>Trailblazers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GAISE level covered</strong></td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td><strong>Variability introduced</strong></td>
<td>No</td>
<td>No</td>
<td>Some</td>
</tr>
<tr>
<td><strong>Context used</strong></td>
<td>Some</td>
<td>No</td>
<td>Some</td>
</tr>
<tr>
<td><strong>Formulate questions component</strong></td>
<td>Pose questions</td>
<td>Pose questions</td>
<td>No</td>
</tr>
<tr>
<td><strong>Collect data component</strong></td>
<td>Classroom Census</td>
<td>Classroom Census</td>
<td>Classroom Census</td>
</tr>
<tr>
<td><strong>Analyze data component</strong></td>
<td>Compare individuals, groups, distribution, bar graphs</td>
<td>Compare individuals, groups, distribution, bar graphs</td>
<td>Compare individuals, groups, distribution, bar graphs</td>
</tr>
<tr>
<td><strong>Interpret component</strong></td>
<td>Inference to classroom</td>
<td>Inference to classroom</td>
<td>Inference to classroom</td>
</tr>
</tbody>
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**Variability**
- GAISE report
- Measurement
- Natural
- Induced
- Missed opportunities in curricula to introduce variability in student lessons
  - Investigations: "Students grab a handful of pattern blocks and make a representation of the types and numbers of pattern blocks they grabbed."
  - Measurement variability could be discussed by having students draw block several times

**Role of Probability**
- **GAISE report:**
  - "Probability is a tool for statistics"
  - "At Level A, students should understand that probability is a measure of the chance that something will happen. It is a measure of certainty or uncertainty."
- **Everyday**
  - Several activities dedicated to finding probabilities of events
  - Discussed the certainty and uncertainty of events occurring
  - Students are asked to roll a 6-sided die and record their results. Teachers then ask about the likelihood of numbers appearing.
  - Students and teachers pose questions about likelihood
  - Students conduct experiment and collect data in order to answer the question
  - Probability is not introduced in the other two curricula
Achieving a statistically literate population

- All three curricula begin to touch on 4 level A components
- More could be done on all the curricula to introduce fundamental ideas of statistics
  - Variability
  - Role of probability
  - Distinction between math and stats

- These curricula offer students and teachers guidance to meet the GAISE suggestions
- In order for students to become statistically literate using these curricula, teachers must have knowledge about the missing information (variability, distinction, role of probability)
- Trailblazers gives teachers tutorials that attempt to do this
- What type of statistical knowledge do teachers need in order to deliver this material?