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Achieving Statistical Literacy in Elementary School Using Current Popular Curricula

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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
  - 1990 funded "Investigations in Number, Data, and Space"
  - 1990 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

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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

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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

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Ingredients needed to achieve statistically literate population

- Curriculum
- Statistically literate teachers

Teachers → Curriculum → Students → Statistical Literacy

- This project focuses on curriculum
  - Do we have this ingredient in place?

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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?

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?
  - Are the components to achieve statistical literacy completed?
  - Is a distinction made between mathematics and statistics?
  - 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
  - Conduct simple experiments (nonrandom assignment)
- Analyze Data
  - Compare individuals
  - Compare individual to group
  - Compare group to group
  - Idea of distribution
  - Describe distribution
  - Observe association between variables
  - Bar graphs, dot plot, stem & leaf, scatter plot, tables, mean, median, mode, modal category
- Interpret Results
  - Inference to classroom
  - Acknowledge results may differ with another class
  - Recognize limitation of scope of inference to classroom

Kindergarten Results

	Investigations	Everyday	Trailblazers
GAISE level covered	A	A	A
Variability introduced	No	No	Some
Context used	Some	No	Some
Formulate questions component	Pose questions	Pose questions	No
Collect data component	Classroom Census	Classroom Census	Classroom Census
Analyze data component	Compare individuals, groups, distribution, bar graphs	Compare individuals, groups, distribution, bar graphs	Compare individuals, groups, distribution, bar graphs
Interpret component	Inference to classroom	Inference to classroom	Inference to classroom

Kindergarten Results

	Investigations	Everyday	Trailblazers
Distinction between mathematics and statistics	No	No	Somewhat
Role of probability in statistics explicitly explained	No	Probability, uncertainty versus certainty	No
Alignment with GAISE	Somewhat	Somewhat	Somewhat

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 asks 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?