

# Changing the Statistics Curriculum for Future and Current High School Mathematics Teachers: A Case Study

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# Iowa State University

- Founded in 1858
  - Land Grant University
  - Strong connection to Agriculture
- Approx. 26,000 students
- Approx. 21,000 undergraduate students
- Research I institution

# Statistics at ISU

- Statistical Laboratory – founded in 1933
- Department of Statistics – founded in 1947
- Centralized Instruction of Statistics
- Teach 4,000 students at undergraduate level each year.
- Offer BS, MS, PhD in Statistics
  - 50 Undergraduate Statistics Majors
  - 150 Graduate Students in Statistics

# Connection to Mathematics

- Several joint faculty members
- Many research collaborations
- Several teaching collaborations

# Mathematics Education at ISU

- Department of Mathematics
  - Controls degree requirements.
- Department of Curriculum and Instruction
  - Assists with courses and student-teacher supervision.

# Iowa Core Curriculum (2006)

- All Iowa High School Students should learn elements of
  - Descriptive Statistics
  - Inferential Statistics
  - Data Collection
  - Probability
- Modeled after
  - NCTM Standards
  - GAISE PreK-12 and College Reports

# Curriculum for Teachers?

- GAISE Reports and NCTM Standards are focused on:
  - Student learning outcomes
  - Pedagogy
  - Tools

# The Mathematical Education of Teachers (MET Report)

- Exploring Data
- Planning a Study
- Anticipating Patterns
- Statistical Inference
- Probability

# CUPM Curriculum Guide

- “. . .study of statistics (is) necessary for those preparing for secondary school teaching in mathematics.”
- “. . .study statistics or probability with an approach that is data-driven.”

# How should we prepare teachers?

- Future Teachers – Course Work
  - Content
  - Pedagogy
- Current Teachers – Master's Degree
  - Content
  - Pedagogy
- Current Teachers – Professional Development
  - Pedagogy

# How were we preparing teachers at ISU?

- Bachelor's Degree in Mathematics with Certification (Future Teachers)
- Master of School Mathematics Degree (Current Teachers)

# Old Curriculum for Future Teachers

## ■ Calculus-Based Probability

– Course Content:

- Probability

- Discrete Distributions

- Continuous Distributions

- Multivariate Distributions

– More traditional approach

# Master of School Mathematics Program

## ■ Goals

- Enhance knowledge of Algebra, Geometry, Calculus, Statistics and Discrete Mathematics
- Provide effective strategies for creating student-centered classroom emphasizing problem solving.
- Training in computing technology in learning and teaching school mathematics.

# Old Curriculum for MSM Program

## ■ Statistical Methods for Research Workers

– Focused on:

- Statistical methods necessary for graduate students outside of statistics to complete their Master's or Ph.D. theses.
- Assumes Introductory Statistics Prerequisite

# New Curriculum for Future Teachers

## ■ Required:

- Introductory Statistics
- Calculus-Based Probability

## ■ Highly Recommended:

- Calculus-Based Mathematical Statistics

## ■ Recommended:

- Applied Regression Modeling
- Design of Experiments and ANOVA

# Introductory Statistics Course\*

- Focused on
  - Data analysis.
  - Interpretations of statistical results in context.
  - Investigation and discovery of statistical concepts.
- Content Coverage
  - Descriptive Statistics
  - Data Collection through Sampling and Experimentation
  - Basic Probability
  - Statistical Inference

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# Calculus-Based Probability

## ■ Focused on

- Data, Simulation, and Mathematical Reasoning
- Differences among Theoretical, Observed and Simulated Probabilities and Distributions
- Properties of Common Discrete and Continuous Distributions

## ■ Content Coverage

- Probability
- Probability Distributions
  - Discrete
  - Continuous
  - Multivariate

# Calculus-Based Mathematical Statistics

## ■ Focused on

- Data, Simulation, and Mathematical Reasoning
- Investigation of Statistical Concepts through both Simulation and Mathematical Proof.
- Connection between Theory and Practice.

## ■ Course Content

- Transformations and Sampling Distributions
- Mathematical Statistics
- From Statistical Theory to Practice and Back

# Applied Regression Modeling

- Focused on

- Data analysis
- Interpretations in context.

- Course content:

- Simple linear regression
- Multiple linear regression
- Regression model diagnostics
- Introduction to Analysis of Variance

# Design of Experiments and ANOVA

## ■ Focused on

- Data Analysis
- Understanding sources of variation in experiments.
- Impact of variability on selection of experimental design.

## ■ Course Content

- One-Factor and Two-Factor Designs and Analyses
- Blocking Designs and Analyses
- Latin Square/Split Plot Designs and Analyses

# New Curriculum for Current Teachers

## ■ Statistical Methods for Mathematics Teachers

- Prerequisite knowledge
  - Calculus-based probability (traditional)
- Content coverage
  - AP Statistics curriculum (without probability emphasis)
  - Multiple regression, design of experiments, analysis of variance, logistic regression
- Pedagogy and tools focus, especially for intro stats curriculum

# Statistical Methods for Math Teachers

- Data Collection Through Sampling and Experimentation
- Analyses of One Categorical Variable
- Analyses of One Quantitative Variable
- Analyses of Contingency Tables
- Analyses of Independent Sample Means
- Simple Linear Regression
- Logistic Regression
- Multiple Linear Regression

# Statistical Methods for Math Teachers

- Structure of each unit
  - Descriptive Statistics
  - Inferential Statistics
    - Data collection
    - Appropriate conclusions in context
  - Mathematical Connections
  - Modeling Pedagogy and Tools

# Future Work – Current Teachers

- Extend Statistical Methods for Math Teachers
  - Iowa State University, University of Iowa, University of Northern Iowa
  - 4-year Colleges
  - Community Colleges
  - High School Mathematics Teachers

# Future Work – Future Teachers

- Changing certification requirements
  - Data-based Introductory Statistics
  - Simulation-driven course in probability
- Endorsement in Statistics?