SIMULATION

AND

STATISTICAL EDUCATION.

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OUTLINE:

* Motivation, Introduction and Background

* Problems in Using Simulation in Teaching.

* Simulation Approaches to Teaching Stats.

* Monte Carlo Simulation in Education.

* GPSS Simulation Example.

* Summary and Conclusions.
I. INTRODUCTION AND BACKGROUND:

* Need: Reach the Students

* Pedagogical Changes Advocated in:
  - ASA Workshops and Conferences
  - ASA Educational Section
  - Electronic and Hard Copy Journals

  * Less is More.
    - Less Theoretical Concepts
    - More Statistical Methods
    - Selection/Priorities/Trade-offs
      - Real Life Examples
      - More Case Studies
    - Inter-Disciplinary Applications
    - More Undergraduate Statistics

II. SIMULATION IN TEACHING

* Teaching Approaches:
  - lecturing
  - Physical Experimentation
  - Simulation
* Problems with Lecturing:

- Boring and Dry
- Lack of Data Collection
- Lack of Group Learning

* Problems With Physical Experimentation:

- Expensive in Time/Resources
- Personal Risks Involved

* Advantages of Simulation:

- Retains uncertainty of outcomes
- Data Collection and Manipulation
  - Less Time Consuming
  - More Time for Case Studies

* Discrete Event Simulation

- Seldom Used for Teaching in Past
  - Difficult to Program in HOL
- Simulation Languages in Main Frame
- At Present, SW Available in PC’s
- Comes With Simulation Textbooks
  - Easy to obtain, learn, operate
* Present Experience Stems from:

- Teaching Applied Statistics
- Teaching Simulation Modelling
- Teaching Statistics With Simulation
  - Workshop for Faculty

III. SIMULATION APPROACHES

* THREE Approaches:

- Independent Course
- Companion Lab
- Embedded in Course

* Independent Course (Applications):

- Complementary but Required
- Data Analysis and Methods
- Real Life/Inter-Disciplinary

* Companion Laboratory:

- Staff with Intermediate Simulation
- Understanding/Operating GPSS
  - Weekly Lab Follows Lecture
- Alternative to Physical Experiments
  - Group Learning (Seed)
- Individual Accountability (Seed)
- Different/Contradictory Results
- Lively Discussions
- Control Over Model/Variables
- Model Assumption Violations
- Realistic/Inter-Disciplinary Examples
- Flexibility in Constructing Examples
- Final Report: Summarization Skills
- Presentations: Communications Skills
- Less Drudgery for Faculty/Students

* Embedded Simulation:

- Staff with Minimal Simulation
  - Running/Operating GPSS
    - Focal Point Faculty
- Class Examples and Homeworks
  - Course Final Projects
- Individual/Group Work (Seed)
- Different/Contradictory Results
  - Easy Example Modifications
  - Different Problem Responses
  - Model Assumption Violations
  - Student Discussions/Interactions

* Stat Methodology Reviewed:

  - GOF/Transformations
  - Simple/Multiple Regressions
    - ANOVA and ANCOVA
  - Response Surface Methodology
- Experimental Design
- Multivariate Analysis
- Non Parametrics
- Time Series Analysis
- Quality Control
- Exploratory Data Analysis
- Use of Statistical Packages

IV. MONTE CARLO SIMULATION

* As A Teaching Tool:

- In-Class Examples
- Final Projects
- Generation of r.v.
- GOF Tests
- Hypothesis Testing
- Test Assumption Violations/Transformations
- Statistical Alternatives
- Performance Measures: Power
- Approximations of the Distribution
- Multi-Dimensionality Problems

V. GPSS SIMULATION EXAMPLE

* Analysis of a System of Small Dams
VI. CONCLUSIONS

* Simulation has used Statistics
* Statisticians Can Now Use Simulation

* This is No Longer a Problem
  - Software (GPSS) Easy to Get
  - Easy to Learn and to Run
  - Saves Programming Time

* Very Flexible/Easy to Modify
* Allows Group Learning/Interaction
* Maintains Individual Accountability
* Relatively Small Faculty Training

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