The ASA GAISE Project:

Guidelines for Assessment and Instruction in Statistics Education

College Report

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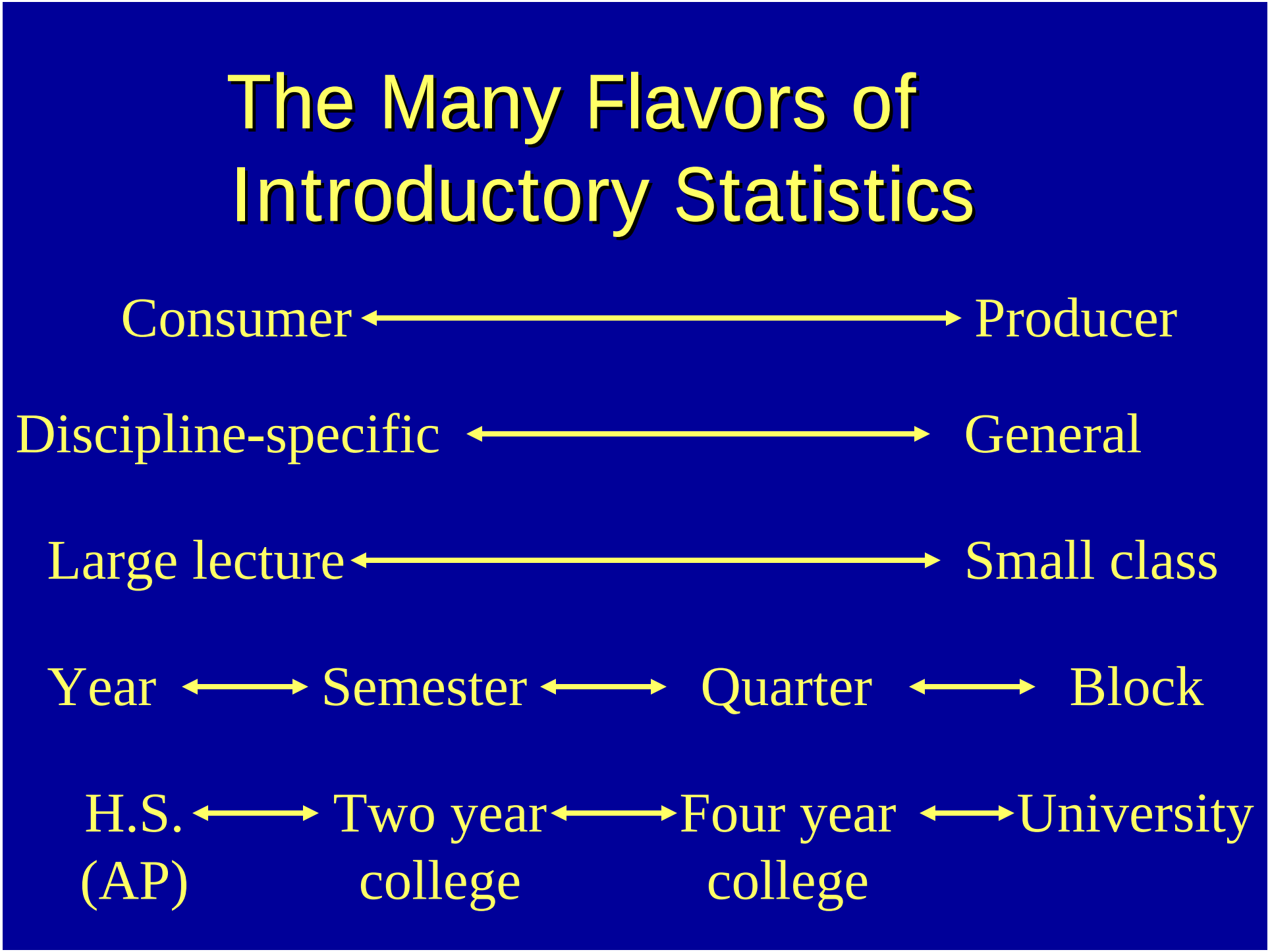
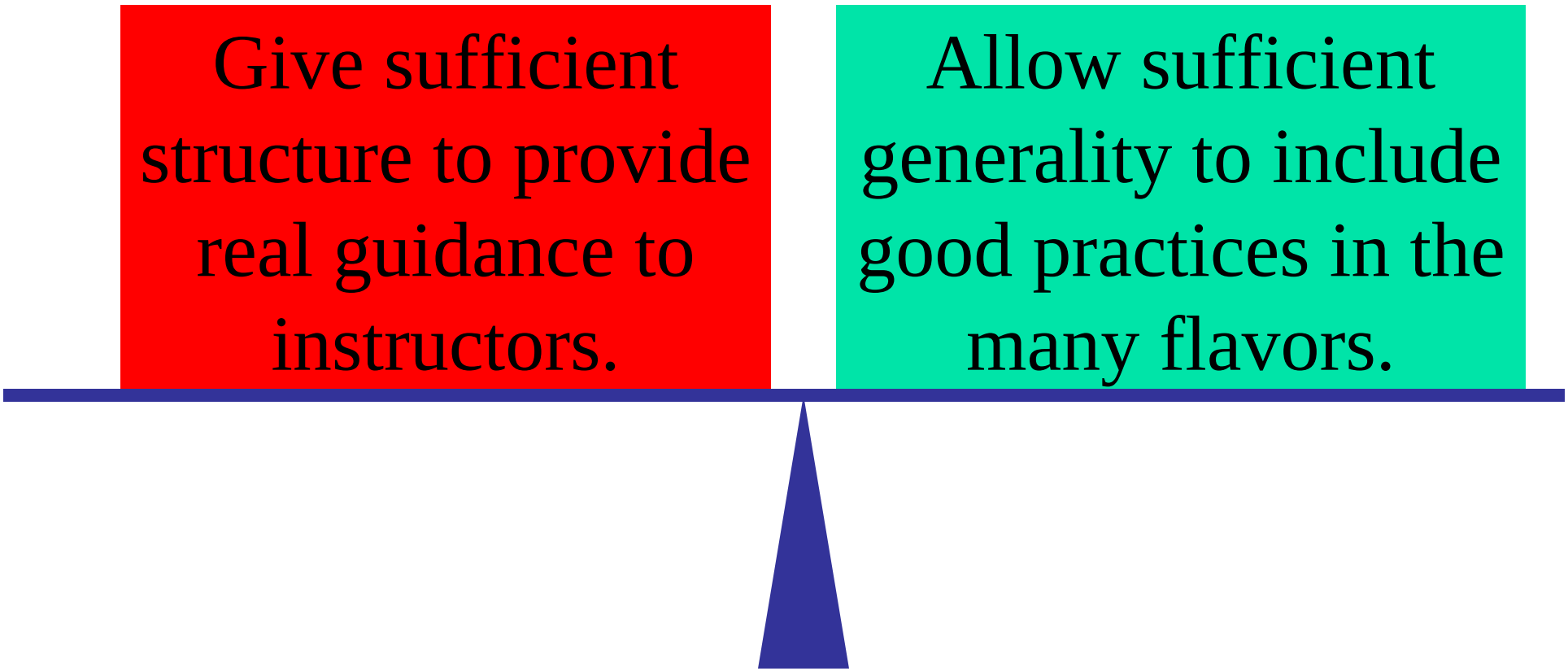
The Goal

Produce a set of recommendations and guidelines for instruction and assessment in introductory statistics courses at the undergraduate level.

The Many Flavors of Introductory Statistics



Challenge in Writing Guidelines



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Four Part Report

- Introduction and History
- Goals for Students in an Introductory Course: *What it Means to be Statistically Educated*
- Six *Recommendations* for helping teachers achieve those goals
- Appendix of *Examples and Suggestions*

Six Recommendations

1. Emphasize statistical literacy and develop statistical thinking
2. Use real data
3. Stress conceptual understanding rather than mere knowledge of procedures
4. Foster active learning in the classroom
5. Use technology for developing conceptual understanding and analyzing data
6. Integrate assessments that are aligned with course goals to improve as well as evaluate student learning.

Recommendation #1

Emphasize statistical literacy and develop statistical thinking.

- **Statistical literacy: understanding the language and ideas of statistics**
- **Statistical thinking: the thought process statisticians use to answer a scientific question with data**

Suggestions for Teachers

Model statistical thinking for students by presenting examples as questions that need an answer, and showing the statistical process for finding the answer.

Work examples from the beginning (the question) to the end (the conclusion).

Example (from *Mind On Statistics*, Utts/Heckard):

Question of interest:

Do men lose more weight by dieting or by exercising regularly?
Study done at Stanford, used overweight male volunteers, randomly assigned to one year of diet or exercise. Lost more weight with diet.

Useful for illustrating these concepts and processes:

- Types of studies (randomized experiment versus observational study)
- Design of randomized experiments
- When cause and effect can be concluded (or not); it can for this experiment
- How to do hypothesis tests, from start to finish
- How to construct and interpret a confidence interval

More Suggestions

- Give students practice developing and using statistical thinking. This should include open-ended problems and projects.

- Give students plenty of practice with choosing appropriate questions and techniques, rather than telling them which technique to use and merely having them implement it.

Example: Choosing the appropriate parameter

TABLE 13.2 The Parameters and Types of Data Used for Inferences About Them

Variable Type (Parameter Type)	One Sample (No Pairing)	Paired Data	Two Independent Samples
Categorical (Proportions)	p	none	$p_1 - p_2$
Quantitative (Means)	μ	μ_d	$\mu_1 - \mu_2$

From *Mind on Statistics,* Utts/Heckard

Choosing the appropriate parameter for the diet and exercise example

- For comparing weight loss for diet versus exercise, what is the parameter of interest?
  - Is weight loss categorical or quantitative?
  - Is there one sample, paired data, or two independent samples?

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Answer: Quantitative, independent samples = $\mu_1 - \mu_2$

Recommendation #2
Use Real Data

See my website →Statistics Links → Examples and Information about Polls, Statistical Studies, etc for links to 34 websites with examples, data sets, applets, etc.:

http://anson.ucdavis.edu/~utts/statlinks.html

Some other Sources for real data:

Textbooks, including CDs that come with them

Websites such as:

- **Recent polls on numerous topics: www.pollingreport.com**
- **"Dazzle" = Data And Storage Library: lib.stat.cmu.edu/DASL/**
- **Journal of Statistics Education data archive:**
  www.amstat.org/publications/jse/jse_data_archive.html

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Recommendation #3

Stress conceptual understanding rather than mere knowledge of procedures.

- Most introductory courses contain too much material.
- If students don't understand the important concepts, there's little value in knowing a set of procedures.
- If they do understand the concepts well, then particular procedures will be easy to learn.
- Concepts should be integrated throughout the course, not taught separately.

Suggestions for Teachers

- View the primary goal as not to cover methods, but to discover concepts.
- Focus on students' understanding of key concepts, illustrated by a few techniques, rather than covering a multitude of techniques with minimal focus on underlying ideas.
- Pare down content to focus on core ideas in more depth.
- Use technology for routine computations, use formulas that enhance understanding.

An Example of Using Formulas for Conceptual Understanding rather than for Computation:

$$s = \sqrt{\frac{\Sigma (y - \bar{y})^2}{n - 1}}$$

~~$$s = \sqrt{\frac{\Sigma y^2 - \frac{1}{n}(\Sigma y)^2}{n - 1}}$$~~

Recommendation #4

Foster active learning in the classroom.

Types of active learning include:

- Group or individual problem solving, activities and discussion.
- Lab activities (physical and computer-based).
- Demonstrations based on data generated on the spot from the students.

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Some Basic Principles

- Activities don't have to be physical, but they have to require *thinking*!! Activities with a prescribed "menu" of steps are not much use.
- Activities probably won't have one "right" way to do them... it's the thought process that counts!
- Activities should mimic a real-world situation. They should not seem like “busy work.” For instance, if you use coins or cards to conduct a binomial experiment, explain some real-world binomial experiments that they could represent.

Some Ideas for Involving Students

IN CLASS

- Thought Questions
- Hands-on Projects

AT HOME OR IN COMPUTER LAB

- Computer Applets

Hands-on Projects

Some examples I use:

- Estimating the probability of “animal eye” landing so that it’s staring at you.
- Collecting and summarizing data of various types.

Two sources for in-class projects:

- Seeing Through Statistics, 3rd edition Activities Manual - 10 projects (Utts, 2005, Brooks/Cole)
- Instructors’ CD for Mind On Statistics, 3rd edition – 35 projects (Utts/Heckard, 2006, Brooks/Cole)

Recommendation #5

Use technology for developing conceptual understanding and ***analyzing data.***

- Graphing calculators
- Statistical packages
- Applets
- Spreadsheets
- Web-based resources including data sources, on-line texts, and data analysis routines
- Audience response systems (“clickers”)

Suggestions for teachers on ways to use technology effectively:

- Access large real data sets
- Automate calculations
- Generate and modify appropriate statistical graphics in class
- Perform simulations to illustrate abstract concepts (after doing by-hand first)
- Explore “what happens if…”- type questions (example: applet in which student adds or moves points, and it updates correlation)
- Create reports

Recommendation #6

Integrate assessments that are aligned with course goals to improve as well as evaluate student learning.

- Students will value what you assess.
- Assessments need to focus on understanding key ideas and not just on skills, procedures, and computations.
- Useful and timely feedback is essential for assessments to lead to learning.
- Various types of assessment may be more or less practical in different types of courses. However, it is possible, even in large classes, to implement good assessments.

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Some Types of Assessment

- Homework
- Quizzes and exams
- Projects
- Activities
- Oral Presentations
- Written reports
- Minute papers
- Article critiques
- Audience response systems (“clickers”)

Suggestions for Teachers

- Integrate assessment into the course as a learning tool.
- Use a variety of assessment methods.
- Assess statistical literacy using assessments such as interpreting or critiquing articles and graphs in the news.
- Assess statistical thinking using assessments such as student projects and open-ended investigative tasks.
- For large classes
  - Use group projects instead of individual projects
  - Use peer review
  - Use multiple choice questions that focus on choosing interpretations (e.g. of graphs and studies) or selecting appropriate statistical procedures.

Recommendations: Making It Happen

Start with small steps, for example:

- Add an activity to your course
- Have your students do a small project
- Integrate an applet into a lecture
- Demonstrate the use of software to your students
- Increase the use of real data sets
- Add a case study (newspaper story <-> journal article)
- Choose one topic to delete from the list you currently try to cover and using the time saved to focus more on understanding concepts.

Recommendations: Making It Happen

Use online resources:

GAISE Reports:
http://www.amstat.org/education/gaise

ARTIST- Assessment Resources:
https://app.gen.umn.edu/artist/

CAUSEWeb:
http://www.causeweb.org

More Good Resources for Statistics Teachers:
http://anson.ucdavis.edu/~utts/statlinks.html

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Seven Important Topics

Reference: Utts, Jessica (2003), What educated citizens should know about statistics and probability, *The American Statistician, 57(2), 74-79*

1. Cause and effect
2. Significance versus importance
3. “No effect” versus low power
4. Biases in surveys/questions
5. Probable coincidences
6. “Confusion of the inverse”
7. Average versus normal

QUESTIONS??