Stat 101 Counts as a Math Competency Requirement, or Why We Moved to a 4-Credit Course

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Abstract

Working with non-statistician colleagues has created rewarding challenges as our university moved from a three to a four credit introductory statistics that also doubles as a mathematics competency university requirement. This session will highlight the expanded topics outline as well as the challenges associated with guiding the statistically challenged colleagues.

Like many statisticians teaching at a university whose mission is excellence in undergraduate teaching, we have always taught a basic three credit introductory statistics course which has been a required course by disciplines such as business, allied health, pharmacy, journalism, and nursing as well as mathematics minors. Throughout the years undergraduates who aspired to graduate school in biology, political science, sociology, education, and history usually managed to enroll in this type of course to fulfill a graduate school prerequisite. At the University of Wisconsin-Eau Claire's (enrollment of 10,000) mathematics department we have two statisticians, one probabilist, applied biological mathematician, and several hybrids teaching introductory statistics to over 500 students per semester.

During the 2002-2003 academic year we decided to offer students a wider choice of options for mathematics competency. At that time a four credit college algebra was the mathematics competency choice for various disciplines who also required basic statistics. The move from a three credit to a four credit statistics course required a public relations team to market the idea across campus before proposing the idea to the university curriculum committee. For the entire academic year the team visited various departments, and presented the proposal that offered additional four credit mathematics courses for competency, i.e., finite mathematic, college algebra, earth algebra, calculus I, pre-calculus, mathematical thinking, and elementary statistics. The team solicited the departments for suggestions, but the main focus was to garner support prior to submitting the proposal to the university curriculum committee. By 2003-2004 the mathematics department had campus wide and curriculum support for this proposal. This 2004-2005 academic year we offered all the proposed courses and most importantly the four credit elementary statistics course with an expanded curricula.

The interesting challenge is that although the mathematical methods for the various topics are not difficult, the non-statistician colleagues usually have not had much personal exposure to such topics as analyses involving Chi-Square, regression, and ANOVA and probably little teaching experience related to these topics. So, part of this four credit basic statistics course that doubles as a mathematics competency involves faculty development. This will be a very time consuming enterprise. Many of our colleagues have definite ideas on the mathematical underpinnings but

desire much needed guidance on the pedagogy. Many are reluctant to develop discovery techniques and student oriented group activities. It will be a most interesting 2005-2006 academic year.

Recently, we have had request from incoming students freshmen whether or not Advanced Placement Statistics will count as the elementary statistics course and mathematics competency. Our general guideline has been a score of three or more will count in both cases. As for transfer students we will take into consideration each situation individually and decide accordingly.

Some hidden benefits: many more students may use the four credit elementary statistics course as a competency and receive information that will benefit them in their daily life, as the only college level analytic course where the students will get exposure to different critical thinking exercises. Faculty will need to rethink their method of delivery. On a personal note teaching load will become more uniform across the department (two sections of a statistics course and an upper level course per semester usually means a full teaching load –12 credits.)

The following is the expanded syllabus outline (see italic font for topics included beyond the three credit basic statistics course.) The textbook currently in use is *Statistics & Informed Decisions, 2004,* by Sullivan, Pearson Publishing.

Elementary Statistics Syllabus Outline, 4 credits

A class period is 50 minutes. Semester is fifteen weeks.

An introductory statistics course should emphasize statistical thinking, data, and concepts, while de-emphasizing recipes and computations. In particular, the course should emphasize collecting data appropriately, conducting exploratory data analysis, verifying assumptions, performing appropriate tests and interpreting the results.

Topics (not necessarily in order of presentation) Approx Number of periods

Data Collection 4

Overview of Data Collection
- Methods of Collection
- Types of Variables

Sampling
- Basic Vocabulary: Sample, Population
- Simple Random Samples

Other types of sampling Block Design, Matched Pairs, (Optional) Stratified random sample

Surveys (Optional)
- Characteristics of a well-designed, well-conducted survey
- Sources of Bias

Experiments (Optional)

Characteristics of a well-designed, well-conducted experiment
Treatment, Control Groups, Replication, Blinding, Placebo Effect
Sources of Bias and Confounding

Exploring Data/Descriptive Statistics

Univariate Data 8

Graphs

Types: Stemplot, histogram, boxplot (Optional: dotplot, bar graph, pie chart, cumulative frequency, time series)

Interpretation: Center, Spread, Shape, Outliers (Optional: Misrepresentation of data)

Numerical Description

Measures of Center: mean and median

Measures of Spread: standard deviation and interquartile range

Measures of Position: quartiles, percentiles, z-scores

Five Number Summary vs. Mean/Standard Deviation

Comparison of Data

Back to Back Stemplot, parallel boxplots

Comparing features of distributions (Centers, spreads, shapes, and outliers)

Bivariate Data 7

Graphs

Scatterplot

Interpretation: form, direction, strength, outliers

Numerical Description

Least-Squares Regression line

Coefficients of Correlation and Determination

Optional: Misuses of regression and correlation, causation, residual plots, influential outliers, Two-way tables for categorical data

Random Variables/Distributions

Probability 3

Basic definition and Properties

Addition Rule for mutually exclusive events

Multiplication Rule for independent events

Optional: general probability rules, conditional probability, tree diagrams, Bayes Rule

Random Variables 11

Discrete, Continuous

Mean and Standard Deviation of a Random Variable

Optional: Mean and Standard Deviation of Transformed Random Variable

Sampling Distributions

Binomial Distribution

Poisson Distribution

Normal Distribution

Empirical Rule, Normal Probability Plots

Law of Large Numbers, Central Limit Theorem

Statistical Inference

Confidence Intervals 6

Introduction

Confidence Level

Types of Intervals

For a single mean, σ known

For a single mean, σ unknown

For a single proportion

For two means: independent, dependent samples

For two proportions

Hypothesis Testing (p-values approach emphasized) 12

Introduction

Logic of testing, setting up hypotheses, p-values, 1 and 2 sided tests, concept of Type I and Type II Errors, Concept of Power

Types of Tests

For a single mean, σ known

For a single mean, σ unknown

For a single proportion

For two means: independent, dependent samples

For two proportions

Chi-Square *4*

Goodness of Fit Test

Association-Contingency Tables

Independence

Analysis of Variance *5*

Inference about regression model

One-way ANOVA

Note about Calculations and Technology:
An introductory statistics course should emphasize statistical thinking, data, and concepts, while de-emphasizing recipes and computations. However, it is necessary to be able to generate the correct values of statistics. Therefore technology should be used to automate calculations, allowing more time to focus on the concepts. In particular, technology should be integrated throughout the course with the following topics, at a minimum, covered using technology:

Descriptive Statistics on Univariate Data

Least-Squares Linear Regression on Bivariate Data

Confidence Intervals and Hypothesis Testing

Chi-Square

One-way Analysis of Variance

Italic font represents additional topics covered in the four-credit course that are not covered in the three-credit course.