TMM010 – INTRODUCTORY STATISTICS (Updated December 8, 2015; Updated with 2016 GAISE Guideline Recommendations, September 27, 2017)

Typical Range 3-4 Semester Hours

This description is intended to apply to a range of introductory courses, from highly conceptual to more traditional presentations. It is assumed that technology is used (calculators, computer packages, or web application software) to minimize involved computations.

This is a course of study that stresses conceptual understanding and critical thinking and introduces statistical methods to college students in all disciplines. The American Statistical Association has developed a set of six recommendations for the teaching of introductory statistics – these recommendations are known as the "Guidelines for Assessment and Instruction in Statistics Education (GAISE)," which are strongly recommended in teaching or developing the introductory statistics course.

The 2016 recommendations are as follows:

1. Teach statistical thinking.
    - Teach statistics as an investigative process of problem-solving and decision-making.
    - Give students experience with multivariable thinking.
2. Focus on conceptual understanding.
3. Integrate real data with a context and purpose.
4. Foster active learning.
5. Use technology to explore concepts and analyze data.
6. Use assessments to improve and evaluate student learning.

To qualify for TMM010 (Introductory Statistics), a course must achieve all of the following essential learning outcomes listed in this document (marked with an asterisk). The Sample Tasks are recommendations for types of activities that could be used in the course.

The successful Introductory Statistics students should be able to:

1. Summarize univariate and bivariate data by employing appropriate graphical, tabular, and numerical methods and describe the attributes of or relationships between the data. These may include (but are not limited to): frequency distributions; box plots; scatter plots; correlation coefficients; regression analysis; and measures of center, variation, and relative position.*

    Sample Tasks:

    - Distinguish between different types of data, such as categorical vs. quantitative variables and ordinal vs. nominal variables.
    - Use and interpret graphical methods for summarizing data sets, such as box plots, histogram, and bar charts.

- Use and interpret numerical methods for summarizing data, such as mean, median, standard deviation, standardized scores, interquartile range, and relative frequency distribution.
- Assess descriptive methods that are most appropriate for highlighting specific features of data.
- Determine the relationship among mean, median and mode based on the shape of various datasets.
- Given bivariate data, choose appropriate graphical representation in order to determine whether a relationship exists between the variables, describe the nature of the relationship, and draw conclusions based on this relationship.
- Interpret the slope of a regression line in the context of the data.
- Make a comparison between datasets by interpreting appropriate data summaries.

2. Identify the characteristics of a well-designed statistical study and be able to critically evaluate various aspects of a study. Recognize the limitations of observational studies and common sources of bias in surveys and experiments. Recognize that association is not causation.*

   Sample Tasks

   Given a research study, the student can:
   - Distinguish between an observational study and an experimental study and discuss the advantages and disadvantages of each;
   - Identify variables, the population of interest and the sampling technique;
   - Compare various sampling techniques and the advantages and disadvantages of each;
   - Identify possible sources of bias and confounding variables;
   - Give several reasons why the results of this study would be challenged; and
   - Interpret correlation vs. causation.

3. Compute the probability of compound events, independent events, and disjoint events, as well as conditional probability. Compute probabilities using discrete and continuous distributions, especially applications of the normal distribution.*

   Sample Tasks:

   - Compute and interpret an appropriate probability to answer probability question, make decisions, and justify conclusions.
   - Distinguish between discrete and continuous distributions.
   - Compute probabilities of events, unions of events, intersection of events, and conditional events in the context of two-way tables.
   - Distinguish disjoint events from independent events.
   - Check for independence of two events, either by computation using the definition or by reasoning based on the design of the experiment; determine when each method is most appropriate.

- Identify situations when it is necessary to compute conditional probabilities; compute conditional probabilities using either the definition or reasoning based on the experiment design; and determine when each method is most appropriate.
- Interpret the area under the density curve for continuous distribution and use it to approximate probabilities or proportions.

4. Explain the difference between statistics and parameters, describe sampling distributions, and generate sampling distributions to observe the Central Limit Theorem.*

   Sample Tasks:

   - Distinguish between the sampling distribution and the population distribution.
   - Describe the terms "statistic" and "sampling variability".
   - Determine mean and standard deviation of the sampling distribution of a statistic.
   - Describe how sample size affects the sampling distribution.
   - Use the Central Limit Theorem in approximating distributions, such as approximating distribution of sample mean, distribution of sample proportion, or Binomial distribution.
   - Generate or simulate sampling distributions to observe, empirically, the Central Limit Theorem.

5. Estimate population parameters using point and interval estimates and interpret the interval in the context of the problem. Summarize the relationship between the confidence level, margin of error, and sample size.*

   Sample Tasks:

   - Given a research objective and raw sample data, the student can:
     - Choose a proper confidence interval estimation method;
     - Verify assumptions behind the estimation method; and
     - Report and interpret confidence interval and margin of error.
   - Evaluate the accuracy of sample estimates using standard errors.
   - Explain how sample size and confidence level affect margin of error in the estimation.
   - Determine the appropriate sample size for a specific margin of error and confidence level.

6. Given a research question, formulate null and alternative hypotheses. Describe the logic and framework of the inference of hypothesis testing. Make decision using p-value and draw appropriate conclusion. Interpret statistical significance and recognize that statistical significance does not necessarily imply practical significance. Perform hypothesis testing with at least one test related to quantitative variable (e.g. t-test for mean, test for linear correlation) and at least one test related to qualitative variable (e.g., test for one population proportion and chi-square test for independence).*

Sample Tasks:

- Given a research objective and raw sample data, the student can:
  - Translate research question or claim into null and alternative hypotheses;
  - Choose a proper hypothesis test;
  - Verify assumptions behind the test; and
  - Use p-value to interpret the statistical significance, make decision, and draw proper conclusion.
- Describe the logic and framework of hypothesis testing.
- Explain and demonstrate the effect of sample size in testing the statistical significance.
- Relate Type I Error and level of significance for the test when making decision.
- Interpret the statistical and practical significance.
- Distinguish between estimation problems and hypothesis testing problems.

7. Throughout this course, students should be given the opportunity to interpret statistical results in context when statistical information is presented in news stories and journal articles.*

Sample Tasks:

Given a research study reported in either news story or journal article, the student can critically evaluate the study report, such as:

- Identifying the relevant population, sample, study units, variables of interest, and sampling method used;
- Distinguishing between observational and experimental study;
- Recognizing whether the study design permits conclusion about causation;
- Interpreting the p-value and confidence interval in context; and
- Describing possible biases in the data collection process.

OHIO TRANSFER MODULE MATHEMATICS, STATISTICS, AND LOGIC: TMM010 INTRODUCTORY STATISTICS COURSE REVISION FACULTY PARTICIPANTS
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