Statistical Literacy in the Undergraduate Psychology Curriculum

Society for the Teaching of Psychology
Statistical Literacy Taskforce 2012

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Statistical Literacy Taskforce 2012 – Learning Goals

Statistical literacy is a fundamental element of undergraduate training in basic and applied psychological science. All students should have a fundamental knowledge and skill base in calculating statistics (whether using computer statistical software or by hand), interpreting basic statistical results, critically evaluating the integrity of the data and the conclusions drawn from the data, distinguishing between statistical and practical significance, describing effect size and confidence intervals, and evaluating the validity of conclusions presented in research reports.

Goal One: Interpret basic statistical results

1.1 Calculate and interpret the meaning of basic measures of central tendency and variability.
1.2 Distinguish between causal and correlational relationships.
1.3 Interpret data displayed as statistics, graphs, and tables.
1.4 Identify and minimize sources of error.

Goal Two: Apply appropriate statistical strategies to test hypotheses

2.1 Identify the types and role of hypothesis formation in hypothesis testing.
2.2 Recognize the difference between a research hypothesis and a statistical hypothesis.
2.3 Select and implement an appropriate statistical analysis for a given research design, problem, or hypothesis.
2.4 Identify the correct strategy for data analysis and interpretation when testing hypotheses.
2.5 Recognize, and when possible, minimize hypothesis testing errors.
2.6 Recognize the limitations of hypothesis testing and identify some of the remedies recommended by the field.

Goal Three: Apply appropriate statistical and research strategies to collect, analyze and interpret data, and report research findings

3.1 Select, apply, and interpret appropriate descriptive and inferential statistics.
3.2 Identify and operationally define variables.
3.3 When appropriate, select valid measures.
3.4 Identify benefits and limitations of experimental design in testing cause-effect relationships.
3.5 Interpret data in the larger research context.
3.6 Limit cause-effect claims to research strategies that appropriately rule out alternative explanations.
3.7 Produce and interpret reports of statistical analyses using APA style.

Goal Four: Distinguish between statistical significance and practical significance

4.1   Distinguish between statistically significant and chance findings in data.
4.2   Calculate and interpret the meaning of basic tests of statistical significance.
4.3   Calculate and interpret the meaning of confidence intervals.
4.4   Calculate and interpret the meaning of basic measures of effect size statistics.
4.5   Recognize when a statistically significant result may also have practical significance.

Goal Five: Evaluate the public presentation of statistics

5.1   Determine whether the appropriate statistical test has been used.
5.2   Recognize when statistics are presented in an inaccurate or misleading way, either
        intentionally or unintentionally.
5.3   Assess the validity of statistical conclusions.
5.4   Determine the accuracy of reported results.

The following guidelines are intended to aid in clarifying the stated goals and expectations of all students completing undergraduate degrees in psychology. Statistical Literacy is a foundational goal for all students obtaining undergraduate degrees in psychology. As a foundational goal, we expect that these elements of statistical literacy are not only actively taught and assessed throughout statistics and research methods classes, but should also be taught, applied, and evaluated in classes throughout an undergraduates' educational career. This committee expects students will need multiple exposures and opportunities to learn about and successfully apply skills in statistical literacy before they can achieve the goals and meet the expectations listed above.

Goal One: Interpret basic statistical results

For students to be able to make sense of the science of psychology, they must be able to make sense of basic statistical results, including measures of central tendency, such as the mean, median, and mode, and measures of variability, such as the variance and standard deviation. Mastering statistics requires an understanding of the relationship of variables: whether one variable is causing changes in another or if variables are covarying with each other. We also expect that students with undergraduate degrees in psychology should be able to accurately and effectively represent quantitative results with basic tables and graphs. Foundational to the understanding of statistics is the role that error plays in masking what is going on with the data. As such, psychology majors should be able to identify various components of error (e.g., sampling error, measurement error, and experimenter error), while identifying ways of minimizing error.

Goal Two: Apply appropriate statistical strategies to test hypotheses

Undergraduate Psychology graduates should be able to apply statistics in testing hypotheses. Students must recognize that the hypothesis, not the data or the statistics, is the driving force in this process and instead, the statistics are merely tools to make sense of the data when answering a question or testing a hypothesis. We expect that students graduating with an undergraduate degree in psychology understand the role that the research hypothesis and the statistical hypothesis play in hypothesis testing. Students must be able to select the appropriate statistic and identify the appropriate strategy for hypothesis testing. Hypothesis testing requires drawing conclusions. As a result, there is always the potential for associated error (e.g., Type I and Type II). We expect students will recognize, and when possible, minimize such errors. We also expect that students will develop a familiarity with the controversies surrounding hypothesis testing, as well as some of the remedies that have been recommended in the field.

Goal Three: Apply appropriate statistical and research strategies to collect, analyze and interpret data, and report research findings

Goals Two and Three are tightly linked. Goal Two focuses on the use of statistics for testing hypotheses. Goal Three places Goal Two into the context of the research methods needed to gather the data that are to be analyzed and thus interpreted. In order to apply statistics in answering questions and testing hypotheses, students must have a fundamental knowledge of what constitutes a testable hypothesis along with being able to follow the steps to test that hypothesis including research design, data collection, data analysis, and interpretation. Principles of psychometrics are also important as the quality of our decision is limited by the quality of our measure. Students need to be able to understand, at a basic level, how to operationally define a variable and identify a valid measure for their study. Moreover, students should recognize that they have to interpret their data in a larger research context, which includes issues of measurement, sampling, and research design. The determination of causal relationships among variables is critical in the field of psychology; as such, we expect students to understand the role of experimental design as well as to use appropriate research methods to rule out alternative explanations for a set of results when they draw conclusions. Students will also need to know how to effectively present results applying APA guidelines in multiple formats including poster, oral, and written presentations.

Goal Four: Distinguish between statistical significance and practical significance

Determining if an effect seen in data is a real or chance finding is the cornerstone of applied statistics. Yet, a "real" effect, one that is statistically significant, may not necessarily translate into a practical or useful finding. Thus, students should be able to calculate and interpret tests of statistical significance, confidence intervals, and effect size statistics as well as distinguish between statistical and practical significance in results.

Goal Five: Evaluate the public presentation of statistics

It is not enough to be able to complete the steps of applying statistics to test a hypothesis or answer a question during a structured class setting. Students must be knowledgeable consumers of the science of psychology. We expect students who graduate with an undergraduate degree in psychology be able to determine if the appropriate statistic has been used in a publicly presented study and whether the conclusions derived from those statistics are valid. During the creation of this list of goals and expectations, few words garnered the level of discussion that one word garnered in Goal 5.2, *Recognize when statistics are presented in an inaccurate or misleading way, either intentionally or unintentionally*. That is, students must be able to recognize when someone is misleading or lying with statistics; this recognition includes concepts like hand selecting data that support one's hypothesis and ignoring the rest, misinterpreting results, hiding unfavorable results, and so forth. Students also should be able to recognize when an investigator has misreported degrees of freedom or when a value of a statistic is outside of a typical range. The knowledge of applied statistics should bring with it the ability of a psychology graduate to know when investigators are using statistics appropriately and when they are not.

The Use of Technology in Statistics and Hand Calculations

Notice what is missing from the goals and expectations of statistical literacy for students with undergraduate degrees in psychology. There is no mention of what, if any, particular computer software or other technology students should be able to use when analyzing data. There is also no mention of whether students should have to be able to conduct hand calculations of statistics. The means by which students can derive a statistic is not nearly as important as is students' abilities to select, apply, and interpret the results from the appropriate statistic. Students are expected to be able to make sense of statistics, whether they have calculated the statistic by hand, they have used technology to calculate the statistic, or someone else has provided the calculations. That having been said, we expect and underscore throughout students' undergraduate programs in psychology that all students have experience in the application of technology in statistics.

The outcome of the Statistical Literacy's Subcommittee on the Undergraduate Psychology Curriculum was created by the collaborative work of the following individuals:

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