Introductory Statistics: Analyzing Data with Purpose

Course Outcomes

Dana Center Mathematics PATHWAYS

Introductory Statistics: Analyzing Data with Purpose (ISAP) is a college-level course intended to explore the topics traditionally included in Introductory Statistics and is intended for students who have placed above Elementary Algebra. For students who place at or below the Elementary Algebra level, this course also provides corequisite support activities that are closely aligned with the in-class activities in the parent course. These support activities are designed to be taught using both co-mingled and cohort structures.

ISAP serves students who are focused on developing statistical skills that will be meaningful for their professional, civic, and personal lives. In this course, an emphasis is placed on the need for data to make good decisions and to understand the dangers inherent in basing decisions on anecdotal evidence rather than on data. Using data to make good decisions requires a deep and meaningful understanding of *data ethics*. To this end, this course emphasizes the importance of data ethics and provides many opportunities to explore ethical practices such as ethical data collection, data privacy, and ethical communication of data-based conclusions.

Contact hours

ISAP is designed to be taught in three contact hours per week when taught in a standard semester, but it also offers optional activities for institutions to teach the course in four contact hours.

Structure of the curriculum

The *ISAP* curriculum is designed around 25-minute in-class activities, which can be taught in groups of one, two, three, or more to conform to the desired class length. These short bursts of active learning, combined with whole class discussions and summaries, produce increased memory retention.[1]

These 25 minute in-class activities are part of a *three-step learning path*, which includes: a **preview assignment** (to be completed before class); an **in-class activity** (with **instructor support materials**); and a **practice assignment** (to be completed after class). Some in-class activities do not have a preview or practice assignment, but all in-class activities include instructor support materials.

Readiness competencies

Students enrolling in *ISAP* should be able to:

[1] Sources: Buzan, T. (1989). *Master your memory* (Typersetters); Buzan, T. (1989). *Use your head* (BBC Books); Sousa, D. (2011). *How the brain learns, 4th ed.* (Corwin); Gazzaniga, M., Ivry, R. B., & Mangun, G. R. (2002). *Cognitive neuroscience: The biology of the mind, 2nd ed.* (W.W. Norton); Stephane, M., Ince, N., Kuskowski, M., Leuthold, A., Tewfik, A., Nelson, K., McClannahan, K., Fletcher, C., & Tadipatri, V. (2010). Neural oscillations associated with the primary and recency effects of verbal working memory. Neuroscience Letters, 473, 172–177; Thomas, E. (1972). The variation of memory with time for information appearing during a lecture. Studies in Adult Education, 57–62.

- Demonstrate procedural fluency with real number arithmetic operations and use those operations to represent real-world scenarios and solve stated problems. Demonstrate number sense, including dimensional analysis and conversions between fractions, decimals, and percentages. Determine when approximations are appropriate and when exact calculations are necessary.
- Solve linear equations, graph and interpret linear models, and read and apply formulas.
- Demonstrate a basic understanding of displays of univariate data such as bar graphs, histograms, dotplots, and circle graphs, including appropriate labeling.
- Take charge of their own learning through good classroom habits, time management, and persistence. Participate in the classroom community through written and oral communication.

Students who do not meet these proficiencies can still be successful in *ISAP* if a corequisite support course is also provided, using the aligned corequisite support activities.

DCMP learning goals applied to *ISAP*

The following five learning goals apply to all DCMP mathematics courses, along with the complexity of problem-solving skills and the increasing use of strategies as students advance through the pathways.

For each DCMP course, we define how the learning goals are applied and the expectations for mastery. Each DCMP course is designed so that students meet the goals across the courses in a given pathway. Within a course, the learning goals are addressed across the course's content-based learning outcomes. The bullet points specify how each learning goal is applied in the *ISAP* course.

Communication Goal: Students will be able to interpret and communicate quantitative information and mathematical and statistical concepts using language appropriate to the context and intended audience.

In the *ISAP* course, students will...

- Use appropriate statistical language in oral, written, and graphical forms.
- Read and interpret graphs and descriptive statistics.
- Read short, authentic texts, such as graphical displays and journal and newspaper articles describing statistical studies. Evaluate the design, analysis, and conclusion of a given study both orally and in written form.

Problem-Solving Goal: Students will be able to make sense of problems, develop strategies to find solutions, and persevere in solving them.

In the *ISAP* course, students will...

- Understand what statistical question is being addressed, use appropriate strategies to answer the question of interest, and state conclusions using appropriate statistical language.

Reasoning Goal: Students will be able to reason, model, and draw conclusions or make decisions with mathematical, statistical, and quantitative information.

In the *ISAP* course, students will...

- Use probability, graphical and numerical summaries of data, confidence intervals, and hypothesis-testing methods to make decisions.
- Support conclusions by providing appropriate statistical justifications.
- Present short written or verbal justifications of decisions that include appropriate discussion of the mathematics involved.
- Engage in ethical practices when collecting data and communicating data-based decisions.

Evaluation Goal: Students will be able to critique and evaluate quantitative arguments that utilize mathematical, statistical, and quantitative information.

In the *ISAP* course, students will...

- Identify errors—such as inappropriate sampling methods, sources of bias, and potentially confounding variables—in both observational and experimental studies.
- Identify mathematical or statistical errors, inconsistencies, or missing information in arguments.

Technology Goal: Students will be able to use appropriate technology in a given context.

In the *ISAP* course, students will...

- Use technology to organize information and make repeated calculations using simple formulas and statistical functions.
- Use the Internet to find statistical information. Topics should be limited to those that can be researched with a simple search.
- Use Internet-based tools appropriate for a given context (e.g., a web-based application to calculate p-values).
- Use technology to calculate descriptive statistics and test hypotheses.
- Interpret and apply output from a statistical software package.

Content learning outcomes for *ISAP*

The outcomes for *Introductory Statistics: Analyzing with Purpose* are:

Data Ethics (DE)

Outcome: Students will demonstrate an understanding of data ethics, including ethical data collection, data privacy, data security, and ethical communication of data-based conclusions.

Data Analysis Process (DP)

Outcome: Students will demonstrate an understanding of the steps in the data analysis process, which are to collect data based on a research objective, summarize data and describe data distributions, analyze data in a way that takes variability into account, and draw appropriate data-based conclusions and communicate results.

Students will be able to:

DP.1 Collect data based on a research objective.

- DP.1.A Distinguish between an observational study and a statistical experiment; select a data-collection method appropriate for a given research objective.
- DP.1.B Evaluate whether conclusions drawn from a statistical study are appropriate given the way in which the data were collected.

  For example: Identify potential sources of bias in sampling and explain why random selection is important in observational studies; identify potential confounding variables and explain why random assignment is important in statistical experiments.

DP.2 Summarize data and describe data distributions.

- DP.2.A Use technology to summarize univariate, bivariate, and multivariable data using appropriate graphical displays and numerical summary statistics.
- DP.2.B Interpret graphical displays and numerical summaries.
- DP.2.C Extract meaning from data visualizations in the media and asses the appropriateness of conclusions drawn from data visualizations.
- DP.2.D Use graphical and numerical methods to make comparisons and explore relationships in multivariable data.
- DP.2.E Determine if it is appropriate to use the Empirical Rule and, if appropriate, use the Empirical Rule to make statements about a distribution.
- DP.2.F Determine if it is appropriate to use the least-squares regression line to model the relationship between two numerical variables and, if appropriate, assess the usefulness of the linear model and use the least-squares regression line to make predictions.

DP.3 Analyze data in a way that takes variability into account.

- DP.3.A Demonstrate an understanding of sampling variability—that the value of a sample statistic varies from sample to sample.
- DP.3.B Use sample data and an understanding of sampling distributions to reason informally about population parameters.
- DP.3.C Use confidence intervals to estimate population parameters and interpret confidence intervals in context.

- DP.3.D Test hypotheses about population parameters and interpret results in context; understand that rejecting a null hypothesis implies strong support for the alternative hypothesis but that failing to reject the null hypothesis does not imply strong support for the null hypothesis.

DP.4 Draw appropriate data-based conclusions and communicate results.

- DP.4.A Describe risks involved when drawing conclusions based on sample data.
- DP.4.B Explain the meaning of “statistically significantly different” in the context of a hypothesis test about a difference in population means or proportions.
- DP.4.C Explain the difference between statistical significance and practical significance, and describe the role of sample size as it relates to determining statistical significance.

DP.5 Support statistical reasoning using probability.

- DP.5.A Interpret probabilities in context.
- DP.5.B Explain the difference between an unconditional probability and a conditional probability.
- DP.5.C Use probability distributions to describe the long-run behavior of a random variable and identify likely and unlikely values.

  For example: Assess whether it is appropriate to use the normal distribution and, when appropriate, use the normal distribution to make probability assessments.