

# *t*-Test Project Instructions and Rubric

## **Project Overview**

1. Choose a research question:
  - a) that can be addressed using a t-test
  - b) for which you can collect data to analyze
2. Devise a plan to collect your data
3. Submit a project plan form to the instructor and obtain approval
4. Once your research question and data collection plan are approved, carry out your research:
  - a) Collect data
  - b) Conduct t-test analysis, using guidelines below
  - c) Write your results in a report, using the outline given below
5. Turn in your written report using the link in Module 9 of the course Blackboard site.

**Data Collection Options:** The following are suggestions on where you can collect data.

1. Reliable/reputable websites (e.g., sponsored by the census bureau, professional sports leagues, universities, real estate agencies, car manufacturers, consumer groups, financial institutions, well-known product manufacturers, restaurants/fast food companies, weather tracking agencies, county/city/state/federal government organizations, etc.)
2. Visit to one or more locations where item(s) you are researching can be found (e.g., stores to write down prices, rivers to count turtles, car dealers to write down data about cars, etc.)
3. Other resource by permission (if you have an idea, ask your instructor).

**Important Note:** ERAU and all other universities have strict policies and approval procedures for any research projects that involve collecting data from human subjects. There is not time in this course for you to go through that approval process. Therefore, your project in this course cannot involve directly collecting data from human subjects. This includes conducting surveys.

## **Project Design**

There are 3 project design options for the t-test project, listed below. To see components and examples for each type of project design, consult the t-test Project Examples Word document or the t-test Project Resources PowerPoint file.

- A. The 1-sample t-test (Sample size must be at least  $n = 40$ .)
- B. The matched pairs t-test (Sample size must be at least  $n = 40$ .)
- C. The 2-sample t-test (independent samples) (Sample size must be at least  $n = 50$ . You may split this across your two samples; for example, you may have two independent samples of size 25, or one of 27 and another of 23, etc. Although your independent samples are not required to be identical in size, it is better if the sample sizes are similar.)

### **Project Plan Form**

Download a copy of the project plan Word document, t-Test Project Plan, save a copy for your records, and then complete the form. Upload the completed form using the link provided in the module assignment item. If the form is not completed satisfactorily, it will be returned to you for revision.

#### **NOTE:**

**Your project plan must be approved by the instructor before you may begin your project!**

### **Project Report Layout and Grading Rubric**

Your final report should be written in paragraph form and should include the following 10 sections: Introduction, Population(s), Variable(s), Data Collection, Study Design, Results – Descriptive Statistics, Results – Confidence interval(s), Results – Hypothesis Test(s), Findings, and Discussion. An explanation of what should be addressed in each section is described below. Read this entire paper prior to beginning your project and use it when writing your project.

All portions of the rubric that will be used to grade your paper are included in the discussion below. There are 20 items in the grading rubric. Each is worth a maximum of 5 points for a total of 100 points. The layout of the rubric is as follows:

| Item Name | Performance necessary to achieve 5 points. | Performance necessary to achieve 4 points. | Performance necessary to achieve 0 to 3 points. |
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**Introduction.** State the topic of your study as a research question AND as a specific hypothesis that you tested; your specific hypothesis should note a statistically significant result that you expected to find AND the **practical reason** that you expected this result (your rationale).

| Overview of Research | Stated clearly: (1) Research question, (2) Expected findings, (3) Rationale | Two of the three criteria at left are satisfied. | Research question and expected findings not stated clearly. Rationale not explained. |
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**Population(s).** Define clearly the population(s) that you intend for your study to represent. (Examples: all NFL football players, all cars manufactured this year, all biology majors at NGCSU, all small towns in the Southeastern U.S., all shoppers at the Daytona Beach Wal-Mart, all houses for sale in Metro Atlanta, etc.)

| Research Population Specified | Targeted population(s) well-defined and appropriate. | Reasonable target population(s) defined, but not fully appropriate | Target population(s) of research project not defined, poorly defined, or incorrect. |
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**Variable(s).** Define clearly the variable(s) that you will obtain during your data collection (e.g., gender, age, salary, price, miles per gallon, score on a particular personality test, miles commuted one-way to school daily, major, etc.) This must be specific: “time spent watching TV” is too vague; “number of hours spent watching TV in the last 3 days” would be specific enough. If your variable is a measurement (e.g., height) give units (e.g., inches). If your variable is a score (e.g., on a personality quiz), give the range of possible scores (e.g., 0 to 15).

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| <b>Definition of Variables</b> | Research variable named; measurement and possible values of variable are clearly defined. | Research variable named, but details are lacking on how variable is measured or quantified. | Research variable not adequately defined. |
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**Data Collection.** Describe your data collection process and sampling strategy. If you located data on a website, provide the URL and tell how you selected individuals from that website to include in your sample. If you obtained data from an agency, office, store, or other similar source, explain where you went and how you selected items to include in your sample. If you collected measurements, describe the device you used (e.g., tape measure, odometer, scale, stopwatch, etc.) *No matter what data collection process you used, address: a) what steps you took to avoid bias in your sample; and b) whether you believe the sample(s) you obtained were representative of the population. Tell why or why not. **Include a table with your raw sample (not summarized) data as an appendix at the end of the report.***

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| <b>Data Collection: Data Sources, Instruments, Measurement</b> | Data collection procedure explained fully, including (1) Source of data identified clearly (website address, etc.), (2) Sound measures taken to ensure accuracy of data, (3) Copy of survey, description of measurement procedures, or other specific data collection details provided. | Two of the three criteria at left are satisfied.                                              | Ineffective data collection procedures OR poor description of data collection procedures. |
| <b>Data Collection: Sampling</b>                               | (1) Sampling strategy explained fully, (2) Sound measures taken to avoid bias explained, (3) Representative sample addressed adequately.                                                                                                                                                | Two of the three criteria at left are satisfied.                                              | Ineffective sampling procedures OR poor description of sampling strategy.                 |
| <b>Data Representation: Raw Data</b>                           | Raw sample data (not summary data) are included in the study in a complete and organized manner.                                                                                                                                                                                        | Raw sample data (not summary data) are given, but presentation is incomplete or disorganized. | Raw sample data used in the study are not provided.                                       |

**Study Design.** Identify the statistical test you conducted to analyze your data. Also tell which **type** of design you used (one-sample, matched pairs, etc.) Give other design details (e.g., was it 1-sided or 2-sided? Left-tailed or right-tailed?) State your null and alternative hypotheses, both in words and in appropriate mathematical symbols. If you used a matched pairs design, explain clearly how the pairs of values were matched and how the difference was computed (e.g., by subtracting before – after, left – right, etc.)

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| <b>Statistical Test and Hypotheses Statement</b> | Correct statistical test and type of design used. Null and alternative hypotheses stated correctly in words AND in mathematical terms. | Some errors in statement of statistical test and type design. Null and alternative hypotheses stated correctly in mathematical terms but not in words or vice versa. | Type of statistical test and/or type design stated incorrectly. Null and alternative hypotheses not stated in mathematical terms or stated incorrectly. |
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**Results: Descriptive Statistics.** Give descriptive statistics (sample size, mean, standard deviation, and 5-number summary) **for each data set**. Note that t-tests for 2 independent samples will require statistics for 2 sets of data-- one for each of the two separate samples. Matched pairs t-tests will require statistics for 3 sets of data-- one for each of the 2 related values (e.g., before and after) and another one for the difference between each pair of numbers. Report each set of descriptive statistics using an appropriate table and chart. All tables and charts should be placed directly in your report. Discuss the implications of the descriptive statistics in terms of your research problem. Discuss whether the conditions necessary for the confidence intervals and hypothesis tests you used are satisfied and support your discussion with appropriate charts/graphs.

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| <b>Descriptive Statistics: Research Variable</b> | For each data set, research variable is described fully, using mean, standard deviation, 5-number summary and appropriate charts and/or graphs. | A summary of the research variable is given for each data set, but at least one summary is incomplete. Charts and/or graphs are used but some are inappropriate. | Descriptive statistics for research variables omitted or not given clearly for each data set. Charts and graphs not included. |
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| <b>Conclusion and Discussion of Descriptive Statistics</b> | Discussion of results of descriptive statistics including summary statistics and chart and graphs is insightful; adds meaning and significance to the report; no unwarranted conclusions. | Adequate discussion of results of descriptive statistics including summary statistics and chart and graphs and their practical implications; reasonable explanation of findings offered; no unwarranted conclusions. | Implications of results of descriptive statistics including summary statistics and chart and graphs not discussed; no attempt to explain findings. Report draws unwarranted conclusions or uses inappropriately certain language. |
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| <b>Data Representation: Charts/Graphs</b> | Conditions necessary for the inferential statistics used in the report to be valid are discussed and verified with appropriate charts, graphs, or tables, or note is made that the confidence intervals or tests may not be valid due to those conditions not being satisfied. | Conditions necessary for the inferential statistics used in the report to be valid are mentioned with an inadequate attempt to verify them or some but not all are verified. | Conditions necessary for the inferential statistics used in the report to be valid are either not mentioned or no attempt is made to verify them. |
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**Results: Confidence Interval.** Report an appropriate confidence interval for your study; include the end points of the confidence interval, margin of error, and description of the meaning.

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| <b>Statistical Analysis – Confidence Intervals</b> | Correct confidence interval(s) used and (1) explanation of all details is thorough, articulate, and precise, (2) accurate end points reported, (3) accurate margin of error reported. | Correct confidence interval(s) used AND two of the three criteria at left are met. | Inappropriate confidence intervals used OR no confidence interval(s) used, reported, or explained correctly. |
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**Results: Hypothesis Test.** Report the results of your hypothesis test; include the test statistic, degrees of freedom, and the p value of the significance test.

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| <b>Statistical Analysis - Hypothesis Test</b> | Correct hypothesis test is conducted and (1) explanation of all details of test is thorough, articulate, and precise, (2) accurate t statistic reported, (3) accurate p-value reported. | Correct hypothesis test is conducted AND two of the three criteria at left are met. | Inappropriate hypothesis test conducted OR hypothesis test not conducted, reported, or explained correctly. |
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| <b>Interpretation of Hypothesis Test and p-Value Results</b> | Includes correct interpretation of the p-value in terms of the specific problem being studied and is correct and consistent with respect to (1) Level of Significance, (2) Rejection of the Null Hypothesis, (3) Real-world conclusion about subject being studied. | Results are interpreted correctly and consistently with respect to: (1) significance, (2) rejection of null hypothesis, (3) real world conclusion about subject being studied. | p-values not interpreted correctly or consistently |
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**Findings.** Interpret the results in the context of your original research question. Do your analyses support your expected findings? Explain. Interpret p-values and discuss significance levels. Compare the results of your confidence intervals and hypothesis test.

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| <b>Conclusion and Discussion of Inferential Statistics</b>            | Discussion of results of inferential statistics in terms of the problem studied including results of confidence interval(s) and hypothesis test(s) is insightful; adds meaning and significance to the report; no unwarranted conclusions. | Adequate discussion of results of inferential statistics in terms of the problem studied and their practical implications; reasonable explanation of findings offered; no unwarranted conclusions. | Implications of results of inferential statistics not discussed; no attempt to explain findings. Report draws unwarranted conclusions or uses inappropriately certain language (such as the hypothesis test proves the hypothesis). |
| <b>Relationship between Hypothesis Tests and Confidence Intervals</b> | Explanation of the relationship between the hypothesis test and confidence intervals is included and correctly explains how conclusions from both techniques are the same.                                                                 | Explanation of the relationship between the hypothesis test and confidence intervals is attempted, but with some minor errors.                                                                     | No attempt is made to explain the relationship between the hypothesis test and confidence intervals, or an attempt is made, but is inaccurate.                                                                                      |

**Discussion.** What conclusions, if any, do you believe you can draw as a result of your study? If the results were not what you expected, what factors might explain your results? What did you learn from the project about the population(s) you studied? What did you learn about the research variable? What did you learn about the specific statistical test you conducted?

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| <b>Summary Discussion of Project</b> | Good discussion of what the student learned from the project, the research variable, the statistical test conducted, and results that can be drawn from the study. Discussion shows insight and thoughtfulness. | Adequate discussion of what the student learned from the project, the research variable, the statistical test conducted, and results that can be drawn from the study. Shows that some thought was given to the implications of the study. | No discussion of what the student learned from the project, the research variable, the statistical test conducted or the discussion is superficial with little thought or insight. |
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The last four items from the grading rubric shown below apply to the report overall, not to a specific section.

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| <b>Project Plan</b>               | Approved project plan form, signed by instructor, is attached to project report.                                      | Approval obtained on project plan, but approval sheet missing from submitted report.                                     | Incomplete or missing project plan or approval not obtained.                                                                         |
| <b>Report Format</b>              | Project report is submitted as a formal paper in paragraph form with full sentences, and is typed and well formatted. | Project report is submitted as a formal paper, but with minor issues (e.g., poor or inconsistent formatting, not typed). | Project report is not submitted as a formal paper OR Final report is written in Excel or other program with no paragraph formatting. |
| <b>Originality and Initiative</b> | An original research topic was selected AND report demonstrates initiative in carrying the project out.               | An original research topic was selected for this project.                                                                | Topic selected is not original; it has been studied frequently by other students.                                                    |
| <b>Writing and Readability</b>    | Report is exceptionally well organized and well written, with all charts and tables embedded in report.               | Report is reasonably organized and readable with few writing errors; all charts and tables are embedded in report.       | Report is poorly organized and hard to follow; charts and tables not embedded in report; many writing errors, awkward sentences.     |