

Tangrams: Two Sample Hypothesis Test

Background

Tangrams is an ancient Chinese puzzle where players arrange geometrically shaped pieces into a particular design by flipping, rotating, and moving them. The online Tangrams game allows students the opportunity to design many versions of the original game. In this activity you play the role of a statistician as you design a study, collect data, and then analyze and interpret the results.

Play the Tangrams game one time using the following settings:

Go to the web site: <https://www.stat2games.sites.grinnell.edu/games/tangrams.html>

a. Enter Player information

- **Player ID:** Use a secret name, any combination of letters and numbers with no spaces. Do not use your name or a term that will identify you.
- **Group ID:** *(given by your instructor)*

[select **PLAY**]

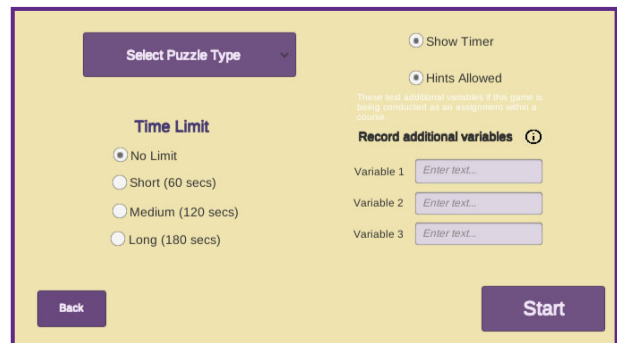
b. Select Puzzle Type: *(given by your instructor)*

c. Time Limit: **No Limit**

d. Select: **Display Timer**

e. Select: **Hints Enabled**

[select **START**]



The screenshot shows the game settings interface. At the top left is a 'Select Puzzle Type' dropdown menu. Below it is the 'Time Limit' section with four radio button options: 'No Limit' (selected), 'Short (60 secs)', 'Medium (120 secs)', and 'Long (180 secs)'. To the right of the 'Time Limit' section are two radio button options: 'Show Timer' (selected) and 'Hints Allowed'. Below these is a section titled 'Record additional variables' with three input fields labeled 'Variable 1', 'Variable 2', and 'Variable 3', each with a placeholder 'Enter text...'. At the bottom left is a 'Back' button and at the bottom right is a 'Start' button.

Conduct a hypothesis test about students in our course

Design your own experiment. Note that these games allow you to develop new factors of your own choice. Which variables do you hypothesize has an impact on game completion time? You could also do a study to determine if various factors influence whether some people choose to use hints. Address each of the following points:

1. Identify two different variables that you hypothesize may impact the completion time for the Tangrams game. Clearly define a question and state the objectives of your experiment.

For example, solving puzzles such as Tangrams requires the use of the spatial orientation functions of the brain. These same brain functions are used extensively by mathematicians, scientists, and engineers to solve complex problems. You may be interested in designing a study that will be able to address the following two questions:

- *Do students who major in Science, Technology, Engineering, and Mathematics (STEM) perform better (on average) at Tangrams than students with other majors?*
- *Does the completion time of spatial reasoning games, such as Tangrams, depend on gender?*

2. State the null and alternative hypotheses corresponding to the objectives you determined in Question 1).

3. All students in the class should play the game. Each student is a subject in this study. In this test, we are conducting an investigation of game completion time. However, we want to make the conditions as similar as possible for all subjects. Determine the settings for each of the following variables on the Tangram Game:

- Time:
- Display Timer:
- Hints Enabled:
- Type of Puzzle:
- Group Name:
- The first explanatory variable:
 - *For example, the first variable could be labeled **STEM Major** with value: **Yes** if your current or intended major is in science, technology, engineering or math and **No** otherwise.*

- The second explanatory variable:
 - *For example the second variable could be labeled **Gender** with value: **M** for males and **F** for females.*

4. Identify the response variable, explanatory variable, and units.

5. How many trials (games) will be played? If each subject plays more than one game, how will you determine the order in which each game will be played?

6. Are there other factors that may be of importance or potentially cause bias in your results? Identify what other conditions need to be controlled during the experiment to eliminate potential biases.

7. Choose an experimental design and an appropriate technique for analysis. Will you use a paired test, two independent samples test or other technique? Keep the design and analysis as simple as possible. A straightforward design and analysis is usually better than complex designs. If the design is too complicated and the data are not collected properly, even the most advanced statistical techniques may not be able to draw appropriate conclusions from your experiment.

8. After all students complete the game, to <http://shiny.grinnell.edu/tangrams/> to view all data from our study (use the same **Group ID** as above). Copy and paste the data into Minitab, Excel, or other statistical software package. Create a histogram or box plot of your data. Identify any outliers or skewness shown in the plot. Identify any potential errors in the data (use the **Player ID** to identify specific data). Correct or delete the erroneous data. Briefly explain any changes you made to the data set and describe why you made these changes.

9. Comment on the shape, center, and spread of particular groups within your data.

10. Use appropriate statistics techniques to calculate a p-value for each hypothesis you are testing.

11. What assumptions need to be checked before we can conclude the analysis in Question 10) is appropriate? State each assumption and provide a graph or other justification to determine whether the assumptions are correct.

12. Use the graph in Question 8) and the p-value(s) to summarize your findings. For example, address the following questions.

- If the model assumptions were not perfectly met, explain how your results might be influenced.
- Explain whether we can use this data to conclude that your results hold for all students at your school.
- Did keeping or removing the outliers influence the results?
- If some of the students used hints and others did not, are the results biased?
- How might a player's background impact his or her ability to play the game?

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