

Abstract and Overview

Problem. Although much has been said on the topic of how to efficiently display data, examples of poorly constructed graphs, tables, and charts are still commonplace – even in academic books on how to analyze and present data to an audience with limited background in assessment, data, and/or statistics.

Overview. This poster synthesizes the thoughts, research, and main ideas of several authoritative writers, scientists, and professional organizations. The purpose is to provide a reference for individuals who may present data on a regular basis to stakeholders but who may not be well-read in the variety of skills, techniques, and research findings regarding best practices for data visualization.

The test of a graph's usefulness is its ability to communicate efficiently and effectively. If it **expresses** the right information clearly and accurately in a way that speaks to your audience, then it is effective. If not, regardless of how pretty it is, it's not only useless, it might even be harmful.

Few (2005a) p. 1

Generally, the ability to store information in our working memory is obviously limited. To account for this, data displays should be created in ways that make interpretation of the results relatively easy. This is not to say that graphs should not be complex; Tufte (2001) noted that we shouldn't underestimate the intelligence and ability of our audience members. Rather, tables and graphs should be constructed to minimize unnecessary effort needed to reach understanding.

The overarching purpose of visual displays should be to show the data - as opposed to simply incorporating fancy colors, showcasing novel computer graphics, or drawing attention to a poster or paper. Displays should also have a main message to convey, and should serve a clear purpose. E.g., tables and graphs serve different purposes, and these should be considered prior to creation and dissemination of data. The following recommendations can be used to more effectively communicate results and findings to an audience using visual displays.



Recommendations

Although there is some evidence that experts concerned with data visualization cite the same authorities, a variety of sources on the subject consistently suggest several best practices.

1. Show the Data. Above all else, remember that the data are the most important part of the message. Don't let them get lost in the display.

2. Identify Message. Figure out what exactly you are trying to convey. Sometimes a simple sentence can carry a message better than a table or a graph. Consider which type of method to present the data will best achieve your main goal(s). See 'Tables vs. Graphs' section.

3. Label Adequately. Several authorities on the subject agree that it is important for a visual display to stand on its own. Include information on the display so that it is understandable without consulting the surrounding narrative. E.g., title, data, axes, time period, source, and important points.

4. Avoid Unnecessary Additions. Excess gridlines, unnecessary color, lines, or decorations, can be distracting, so remove them completely. (See Recommendation #1!) Also, remember that many people are color blind. If color is necessary, use the website <u>VisCheck</u> to ensure your chart isn't difficult to read for those individuals.

5. Sort by the Data. Help your audience to better interpret the results by sorting the by the values observed. See the example below.

6. Avoid Pie Charts. Although this is a common recommendation, pie charts are frequently used. (See Microsoft Excel defaults.) The problem is that it is generally difficult for people to interpret area; better alternatives exist!

7. Label Data Directly. For line graphs and bar graphs, instead of relying on a legend which requires a lot of working memory effort, label the line or bar directly for ease of use. Put labels in the color of the line/bar.

8. Include Reference Points. When possible/appropriate, include reference points, criteria, or benchmarks to aid in quick interpretation of the results. E.g., include a line for a target score, the state average, or last year's average next to the institution's observed score(s).

9. Show Spread/Error. For more sophisticated research, use 95% confidence intervals (margin of error) around point estimates and focus on estimation and effect sizes over *p*-values.

6 Demonstrating a Positive and Engaging Learning Environment | 87.3% 1 Planning for Content Understandings | 71.0% 7 Engaging Students in Learning | 62.2% 8 Deepening Learning During Instruction | 62.2% 3 Using Knowledge of Students to Inform Planning | 60.6% 4 Identifying and Supporting Language Demands | 60.3% 2 Supporting Students' Learning Needs | 58.3% 9 Subject-Specific Pedagogy | 57.7% 5 Planning Assessment to Monitor Student Learning | 54.4% 12 Providing Feedback to Guide Learning | 50.2% 11 Analyzing Student Learning | 45.9% 15 Using Assessment to Inform Instruction | 41.0% 10 Analyzing Teaching Effectiveness | 37.8% 14 Evidence of Language Use to Support Content Learning | 34.5% 13 Supporting Students' Use of Feedback | 25.7%

Examples

The only worse design than a pie chart is Tufte (2001) p. 178

Effective Visual Data Displays

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Use Tables When

- The display will be used to look up individual values.
- It will be used to compare individual values.
- Precise values are required. • The quantitative values include
- more than one unit of measure. Both detail and summary values are included

Many individuals and groups (including many professionals not mentioned here) are doing great work with data visualization or can be referred to as resources for ideas, techniques, and inspiration when creating visual data displays.

For example, see: <u>fivethirtyeight</u>, <u>Perceptual Edge</u>, <u>Data Hero</u>, <u>The</u> University of Reading, Vanderbilt University, OpenIntro Statistics,

For those interested, the <u>R Statistical Programming Language</u> allows for free, customizable data analysis and data presentation using a variety of existing packages created by professionals in the field.

Recommendations

- \checkmark Show the data above a
- ✓ Identify your purpose,
- ✓ Label data, axes, impor
- ✓ Avoid unnecessary add
- ✓ Sort/organize categorie
- ✓ Avoid pie charts^{*}
- ✓ Avoid legends label d
- ✓ Include criteria and/or

Show spread, distributi

* Nicol & Pexman (2010) state that pie charts are not often used in psychology, but they do actually offer guidelines for their inclusion in manuscripts and reports.

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- Washington, DC: American Psychological Association.
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Tables vs. Graphs

Use Graphs When

The message is contained in the shape of the values (e.g., patterns, trends, and exceptions).

The display will be used to reveal relationships among whole sets of values.

Few (2012) p. 51

Additional Resources

Takeaway Points

	Reference(s)
ll else – multivariate format is a plus	3,5,6,7,11
main question, message, and or goal	5,6,7,11
tant events, and cite sources	2,5,6,7,8,9,11
litions – e.g. excess gridlines, color	5,6,7,9,10,11
es by the data	5,6,7
	4,5,6,11
lata directly, when possible	5,6,9,11
benchmarks in charts for comparison	3,5,6
ion, and/or margin of error	1,2,3

References

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11. Tufte, E. R. (2001). The visual display of quantitative information (2nd ed.). Cheshire, CT: Graphics Press.