Data Visualization Basics for Survey Data

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Data Visualization Basics
Why visualize data?

Mean of x: 9  
Mean of y: 7.5  
Standard Deviation of x: 3.3  
Standard Deviation of y: 2

Statistician Francis Anscombe, 1973
Why visualize data?
What is data visualization?

Encoding of **data** using **visual information**

<table>
<thead>
<tr>
<th>Graduation Year</th>
<th>Gender</th>
<th>Height (m)</th>
<th>How satisfied were you with your experience in this program?</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Female</td>
<td>1.7</td>
<td>Very Satisfied</td>
</tr>
<tr>
<td>2011</td>
<td>Male</td>
<td>1.55</td>
<td>Somewhat Satisfied</td>
</tr>
</tbody>
</table>

Quantitative discrete | Categorical | Quantitative continuous | Ordinal

Main goal of data visualization

Communicate data to an audience as effectively and accurately as possible

Data → Visual Information

(Goal is not to create something colorful and shiny that will take up some space on the page)
Graphs to recommend
Graphs to avoid

Any 3D chart
Graphs to avoid

Pie charts or donut chart
Graphs to avoid

Pie charts or donut chart
A note on color

Use color sparingly and consciously!!

1- Are you using color to represent a variable? Consider types of color palettes, and decide which one is most appropriate for your data.

- Categorical
- Sequential
- Diverging

Note about categorical palettes:

- If there are more than 4-5 categories, do not use color to represent the variable.
- Consider the following: are you trying to highlight a category? Is one category alarming? Are you trying to bring less attention to one category (e.g. “all others”)? Color choices can make a big difference in communicating that.

2- Gestalt Principles of Visual Perception: principle of association: if two elements have the same color, the brain will automatically perceive them as being associated. Would take additional time to read and understand that same color now represents something else. Therefore, use color consistently across charts.

3- Remember that approximately 8% of men and 0.5% of women are color blind: avoid red and green together!
A note on color
Applying data visualization basics to survey data
Example 1 - Likert scale

Survey: NSSE 2018

Topic: Collaborative Learning

Question: During the current school year, how often have you done the following:

- Asked another student to help you understand course material
- Prepared for exams by discussing or working through course material with other students
- Worked with other students on course projects or assignments
- Explained course material to one or more students

Answer choices: Very often, often, sometimes, never. (Likert scale).

Goal: Understand how our students answered this question - how much collaborative learning are they doing?
Version 2 (Excel default)

Collaborative Learning

During the current school year, how often have you done the following?

- Asked another student to help you understand course material
- Explained course material to one or more students
- Prepared for exams by discussing or working through course material with other students
- Worked with other students on course projects or assignments

Legend:
- Never
- Often
- Sometimes
- Very often
Collaborative Learning

During the current school year, how often have you done the following?

- Asked another student to help you understand course material
- Explained course material to one or more students
- Prepared for exams by discussing or working through course material with other students
- Worked with other students on course projects or assignments

% of respondents

- Never
- Sometimes
- Often
- Very often
Collaborative Learning
During the current school year, how often have you done the following?

- Worked with other students on course projects or assignments
- Prepared for exams by discussing or working through course material with other students
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- Asked another student to help you understand course material

% of respondents

- Never
- Sometimes
- Often
- Very often
Collaborative Learning

During the current school year, how often have you done the following?

- Worked with other students on course projects or assignments
- Prepared for exams by discussing or working through course material with other students
- Explained course material to one or more students
- Asked another student to help you understand course material

% of respondents
Collaborative Learning

During the current school year, how often have you done the following?

- Worked with other students on course projects or assignments:
  - Never: 10%
  - Sometimes: 16%
  - Often: 45%
  - Very often: 29%

- Prepared for exams by discussing or working through course material with other students:
  - Never: 14%
  - Sometimes: 28%
  - Often: 33%
  - Very often: 24%

- Explained course material to one or more students:
  - Never: 4%
  - Sometimes: 29%
  - Often: 42%
  - Very often: 25%

- Asked another student to help you understand course material:
  - Never: 8%
  - Sometimes: 15%
  - Often: 47%
  - Very often: 30%

% of respondents
Collaborative Learning

During the current school year, how often have you done the following?

<table>
<thead>
<tr>
<th>Activity</th>
<th>% of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worked with other students on course projects or assignments</td>
<td>26%</td>
</tr>
<tr>
<td>Prepared for exams by discussing or working through course material with other students</td>
<td>42%</td>
</tr>
<tr>
<td>Explained course material to one or more students</td>
<td>33%</td>
</tr>
<tr>
<td>Asked another student to help you understand course material</td>
<td>23%</td>
</tr>
</tbody>
</table>
### Collaborative Learning

During the current school year, how often have you done the following?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never or Sometimes</th>
<th>Often or Very Often</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepared for exams by discussing or working through course material with other students</td>
<td>42%</td>
<td>58%</td>
</tr>
<tr>
<td>Explained course material to one or more students</td>
<td>33%</td>
<td>67%</td>
</tr>
<tr>
<td>Worked with other students on course projects or assignments</td>
<td>25%</td>
<td>74%</td>
</tr>
<tr>
<td>Asked another student to help you understand course material</td>
<td>23%</td>
<td>77%</td>
</tr>
</tbody>
</table>

Focus on respondents who answered negatively
### Version 7

**Collaborative Learning**
During the current school year, how often have you done the following?

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% of respondents

- **Never or Sometimes**
- **Often or Very Often**

**Focus on respondents who answered negatively**

**Focus on respondents who answered positively**

**Collaborative Learning**
During the current school year, how often have you done the following?

<table>
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<tr>
<th>Activity</th>
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<th>Often or Very Often</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asked another student to help you understand course material</td>
<td>77%</td>
<td>23%</td>
</tr>
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<td>74%</td>
<td>25%</td>
</tr>
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<td>33%</td>
</tr>
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<td>Prepared for exams by discussing or working through course material with other students</td>
<td>58%</td>
<td>42%</td>
</tr>
</tbody>
</table>

% of respondents

- **Often or Very Often**
- **Never or Sometimes**
Example 2 - multiple categories

**Data:** Same.

**Goal:** Understand how collaborative learning varies between groups of students.
Multiple categories - option 1

Collaborative Learning
During the current school year, how often have you done the following? (% of respondents who answered "Often" or "Very Often")

- Explained course material to one or more students: 64% (Senior), 81% (First Year)
- Worked with other students on course projects or assignments: 79% (Senior), 75% (First Year)
- Prepared for exams by discussing or working through course material with other students: 66% (Senior), 56% (First Year)
- Asked another student to help you understand course material: 70% (Senior), 63% (First Year)

% of respondents
Collaborative Learning
During the current school year, how often have you done the following? (% of respondents who answered "Often" or "Very Often")

- Explained course material to one or more students: 71% (Arts & Sciences), 81% (Business & Economics), 70% (P.C. Rossin Engrg & Applied Sci)
- Worked with other students on course projects or assignments: 55% (Arts & Sciences), 62% (Business & Economics), 65% (P.C. Rossin Engrg & Applied Sci)
- Prepared for exams by discussing or working through course material with other students: 64% (Arts & Sciences), 79% (Business & Economics), 77% (P.C. Rossin Engrg & Applied Sci)
- Asked another student to help you understand course material: 76% (Arts & Sciences), 72% (Business & Economics), 73% (P.C. Rossin Engrg & Applied Sci)
Multiple categories - option 2

Small multiples: Instead of representing all the values with length along the same axis, separate into multiple identical axis. The college is not represented using color but using position. Lower cognitive load.

Collaborative Learning
During the current school year, how often have you done the following?
(% of respondents who answered "Often" or "Very Often")

<table>
<thead>
<tr>
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<th>Arts &amp; Sciences</th>
<th>Business &amp; Economics</th>
<th>P.C. Rossin Engrg &amp; Applied Sci</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explained course material to one or more students</td>
<td>71%</td>
<td>81%</td>
<td>70%</td>
</tr>
<tr>
<td>Worked with other students on course projects or assignments</td>
<td>55%</td>
<td>62%</td>
<td>65%</td>
</tr>
<tr>
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<td>79%</td>
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<td>72%</td>
<td>73%</td>
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Collaborative Learning

During the current school year, how often have you done the following?

(% of respondents who answered "Often" or "Very Often")

- Explained course material to one or more students
- Worked with other students on course projects or assignments
- Prepared for exams by discussing or working through course material with other students
- Asked another student to help you understand course material
# Collaborative Learning

During the current school year, how often have you done the following?

(\% of respondents who answered "Often" or "Very Often")

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<tr>
<th>Activity</th>
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<td>72%</td>
<td>73%</td>
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</table>
Example 3 - Longitudinal analysis


Topic: Perceived Gains

Question: How much has your experience at Lehigh contributed to your knowledge, skills, and personal development in the following areas?

- Writing clearly and effectively
- Speaking clearly and effectively
- Thinking critically and analytically
- Analyzing numerical and statistical information

Answer choices: Very Much, Quite a bit, Some, Very Little (Likert scale).

Goal: See how the % of students who answered “Quite a bit” or “Very Much” changed over time, and across questions.
Version 1
How much has your experience at Lehigh contributed to your knowledge, skills, and personal development in the following areas?
(% responding "Quite a bit" or "Very much")

- Writing clearly and effectively:
  - 2009: 82%
  - 2012: 70%
  - 2015: 70%
  - 2018: 83%

- Speaking clearly and effectively:
  - 2009: 70%
  - 2012: 62%
  - 2015: 64%
  - 2018: 60%

- Thinking critically and analytically:
  - 2009: 52%
  - 2012: 50%
  - 2015: 50%
  - 2018: 50%

- Analyzing numerical and statistical information:
  - 2009: 52%
  - 2012: 50%
  - 2015: 50%
  - 2018: 50%
How much has your experience at Lehigh contributed to your knowledge, skills, and personal development in the following areas?

(\% responding "Quite a bit" or "Very much")

- Thinking critically and analytically: 70\%
- Speaking clearly and effectively
- Writing clearly and effectively: 60\%
- Analyzing numerical and statistical information

Years: 2009, 2012, 2015, 2018
In conclusion

1. No single option or right/wrong option when choosing how to represent your data.

2. Choose a visualization option based on the data you have, what you are trying to communicate, and who is your audience.

3. Design with purpose - don’t stick with the software defaults: change the colors, remove colors, remove lines, decide where your axis starts and ends, decide where to add text/labels, etc.

4. Clean up your data visualization: Remove clutter such as borders, gridlines, axis labels, legends, etc. to lower cognitive load of the reader/audience. Think: if I remove this, would it change anything?

Optimize your data/ink ratio. [https://images.squarespace-cdn.com/content/56713bf4dc5cb41142f28d1f/1450306653111-70K5IT30R69NWPDIE1ZJ/data-ink.gif?content-type=image%2Fgif](https://images.squarespace-cdn.com/content/56713bf4dc5cb41142f28d1f/1450306653111-70K5IT30R69NWPDIE1ZJ/data-ink.gif?content-type=image%2Fgif)
Sources

Storytelling with Data: A Data Visualization Guide for Business Professionals by Cole Nussbaumer Knaflic


Toptal color blind filter: https://www.toptal.com/designers/colorfilter/
Questions?