Data Visualization Basics for Survey Data

Caroline Seguin, Business Intelligence Analyst, Office of Institutional Research and Strategic Analytics

Lehigh University Student Affairs Sixth Annual Assessment Symposium
January 9th, 2020

Data Visualization Basics

Why visualize data?

I		II		III		IV	
x	**y**	**x**	**y**	**x**	**y**	**x**	**y**
10	8.04	10	9.14	10	7.46	8	6.58
8	6.95	8	8.14	8	6.77	8	5.76
13	7.58	13	8.74	13	12.74	8	7.71
9	8.81	9	8.77	9	7.11	8	8.84
11	8.33	11	9.26	11	7.81	8	8.47
14	9.96	14	8.1	14	8.84	8	7.04
6	7.24	6	6.13	6	6.08	8	5.25
4	4.26	4	3.1	4	5.39	19	12.5
12	10.84	12	9.13	12	8.15	8	5.56
7	4.82	7	7.26	7	6.42	8	7.91
5	5.68	5	4.74	5	5.73	8	6.89

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?
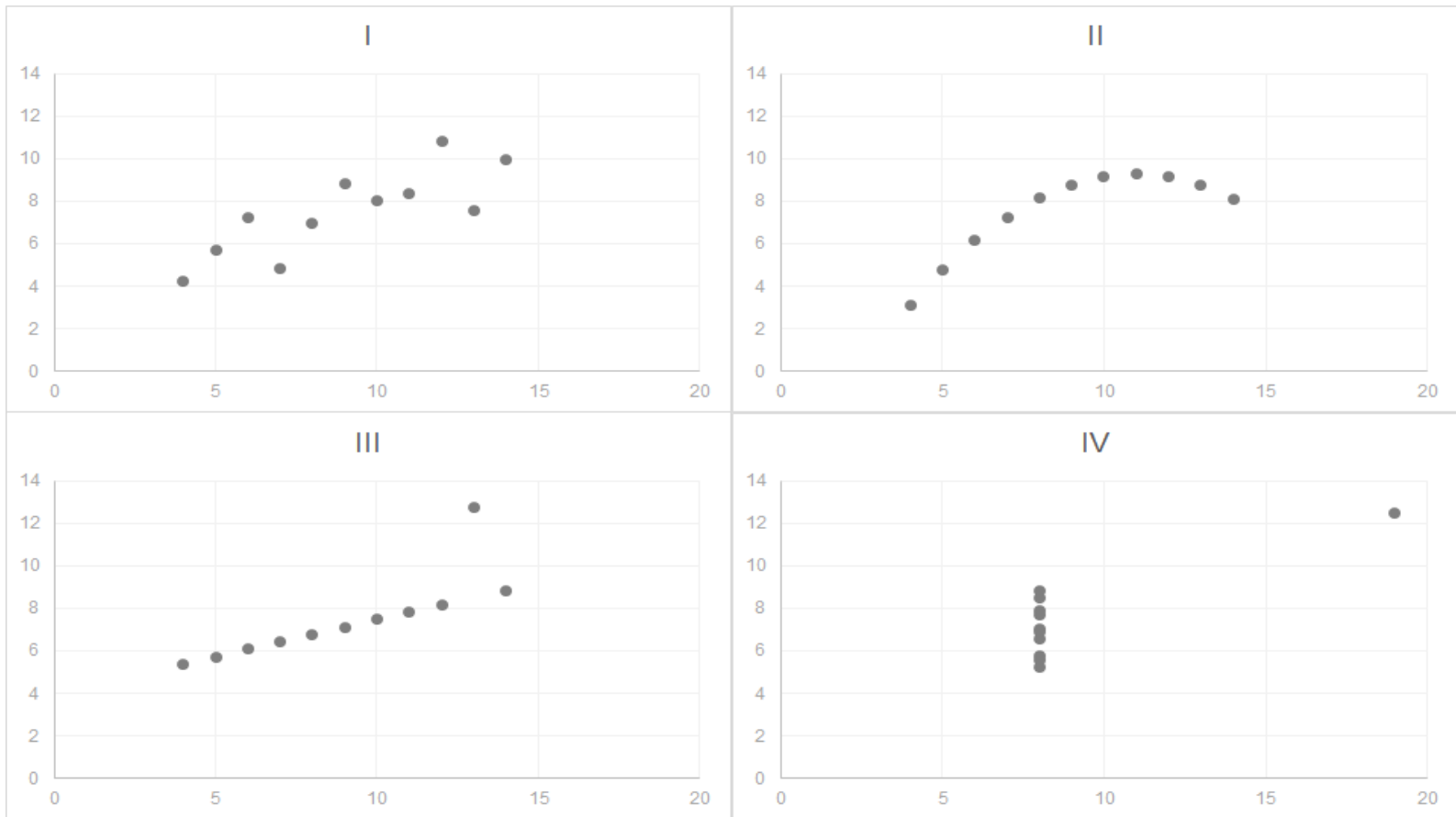
What is data visualization?

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

Graduation Year	Gender	Height (m)	How satisfied were you with your experience in this program?
2012	Female	1.7	Very Satisfied
2011	Male	1.55	Somewhat Satisfied

Quantitative discrete

Categorical

Quantitative continuous

Ordinal

More Accurate

Position

Length

Angle, Slope

Area

Volume

Color (Saturation)

Color (Hue)

Cleveland, William S., and Robert McGill. "Graphical Perception and Graphical Methods for Analyzing Scientific Data." *Science*, vol. 229, no. 4716, 1985, pp. 828–833.
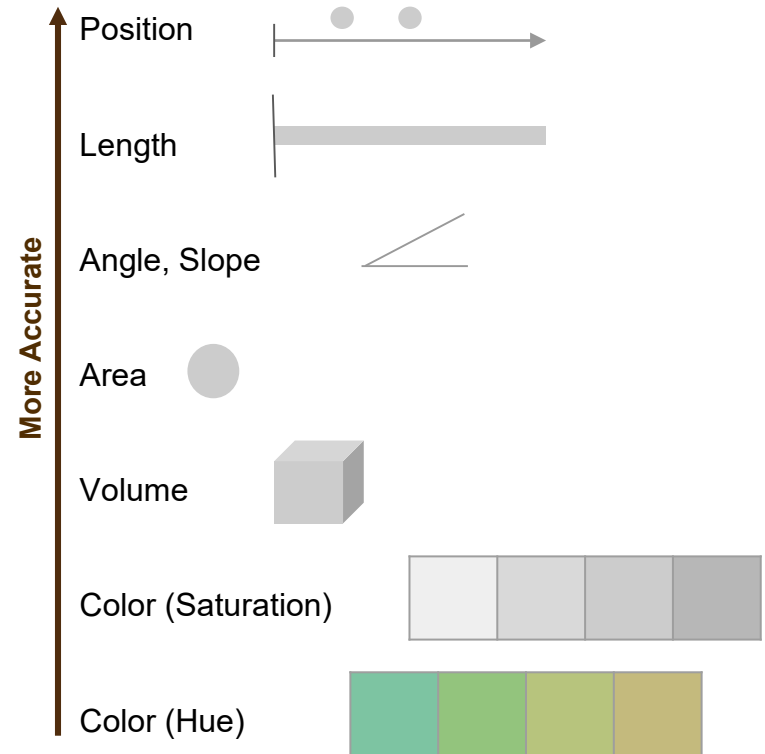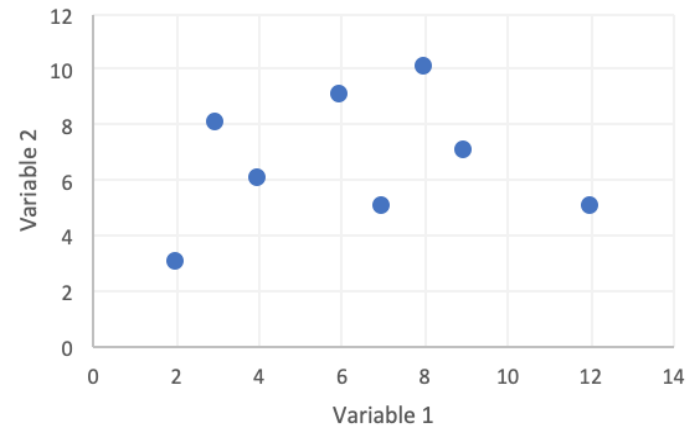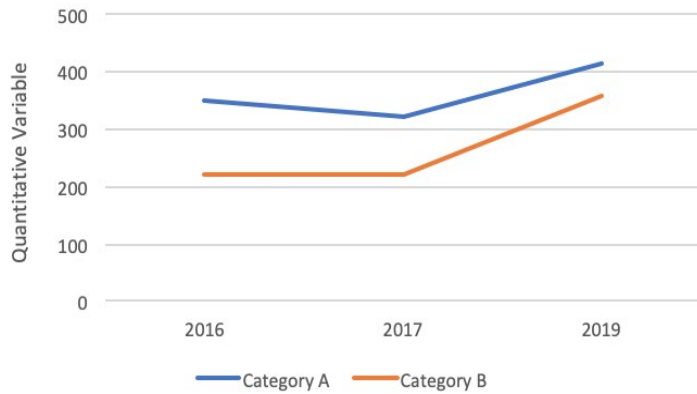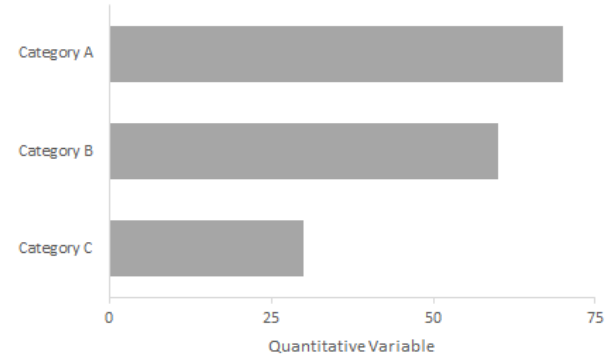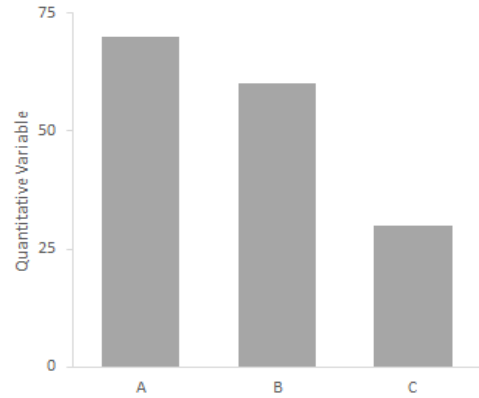
Main goal of data visualization

Communicate data to an audience as effectively and accurately as possible
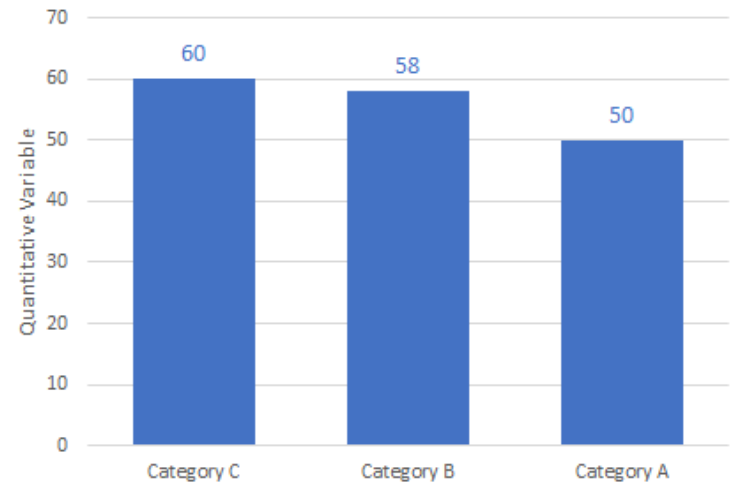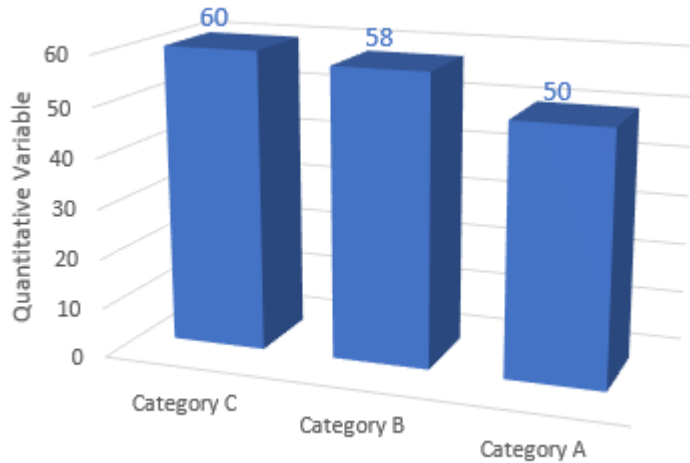
Data ⟶ Visual Information

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

Graphs to recommend
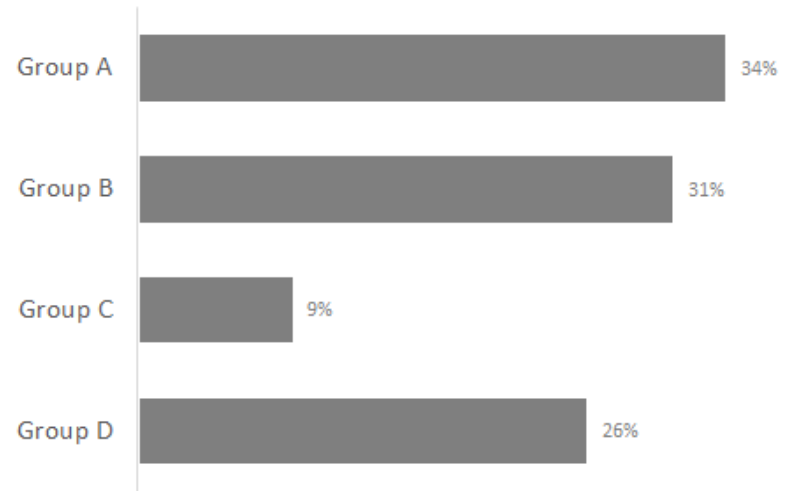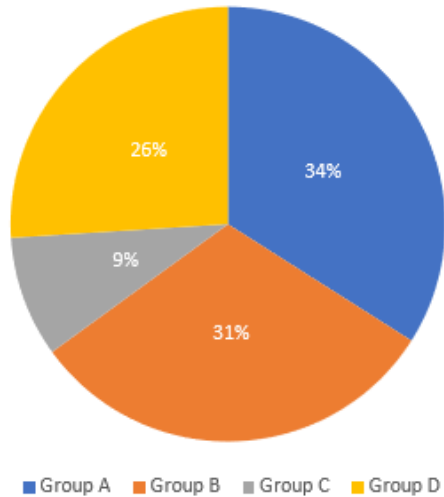
Graphs to avoid

Any 3D chart

Graphs to avoid

Pie charts or donut chart

Graphs to avoid

Pie charts or donut chart

A note on color

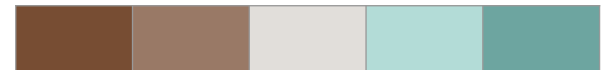**Use color sparingly and consciously!!**

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
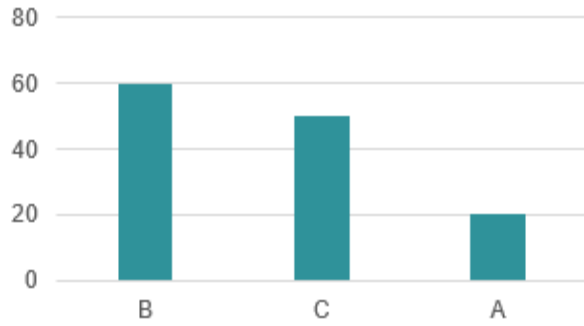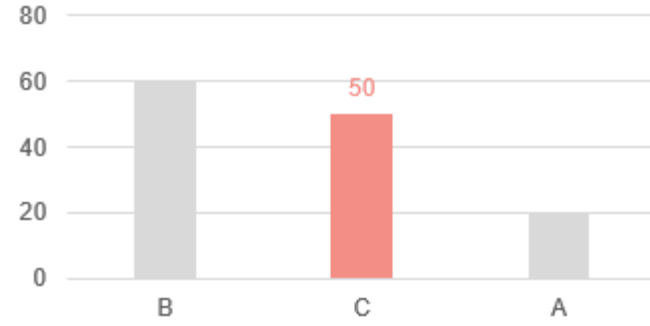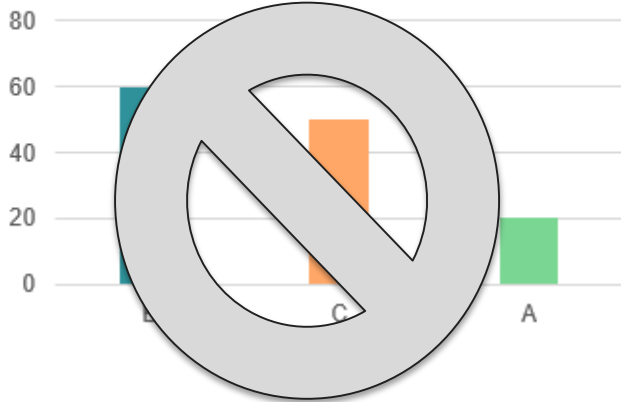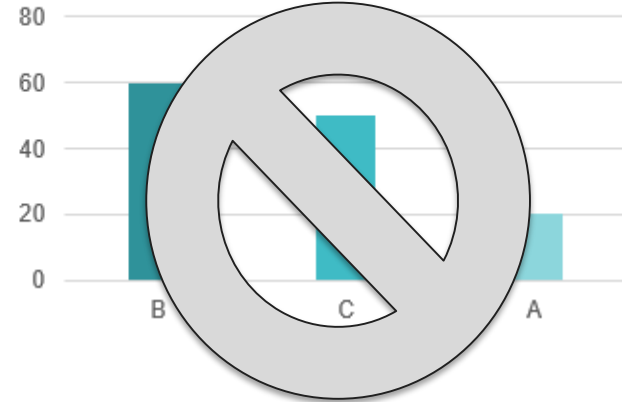
Applying data visualization basics to survey data

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?
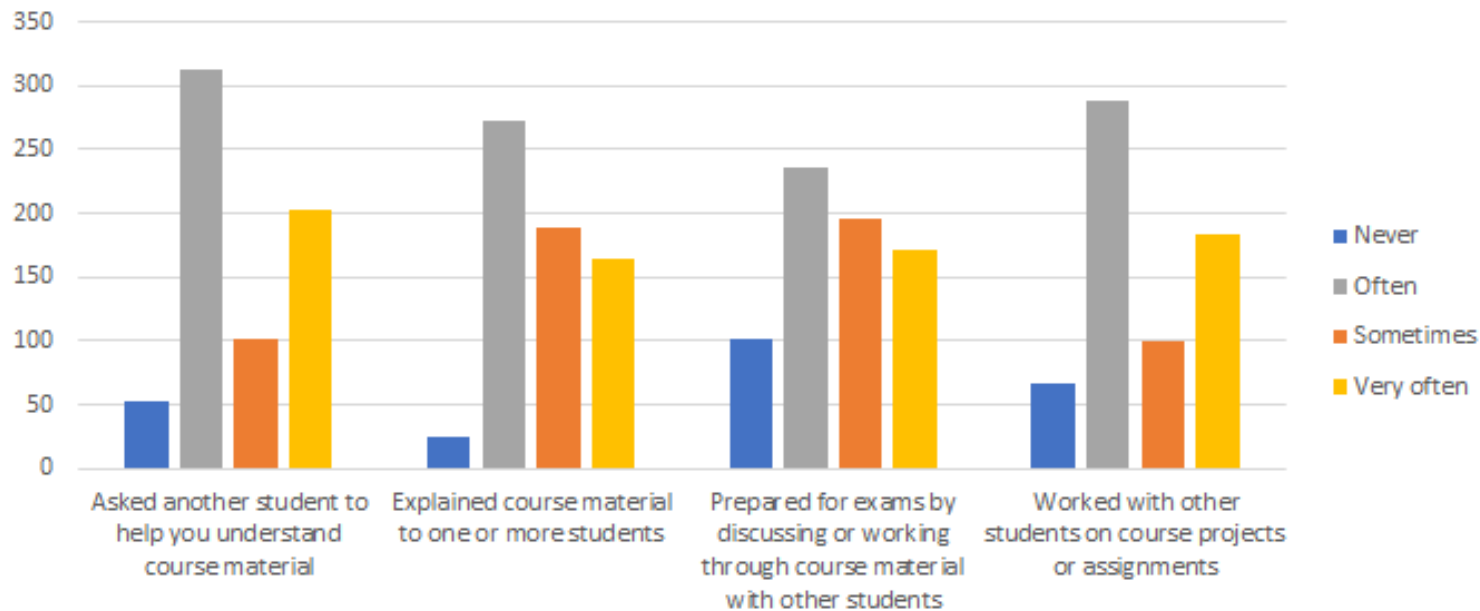
Version 2

Collaborative Learning
During the current school year, how often have you done the following?
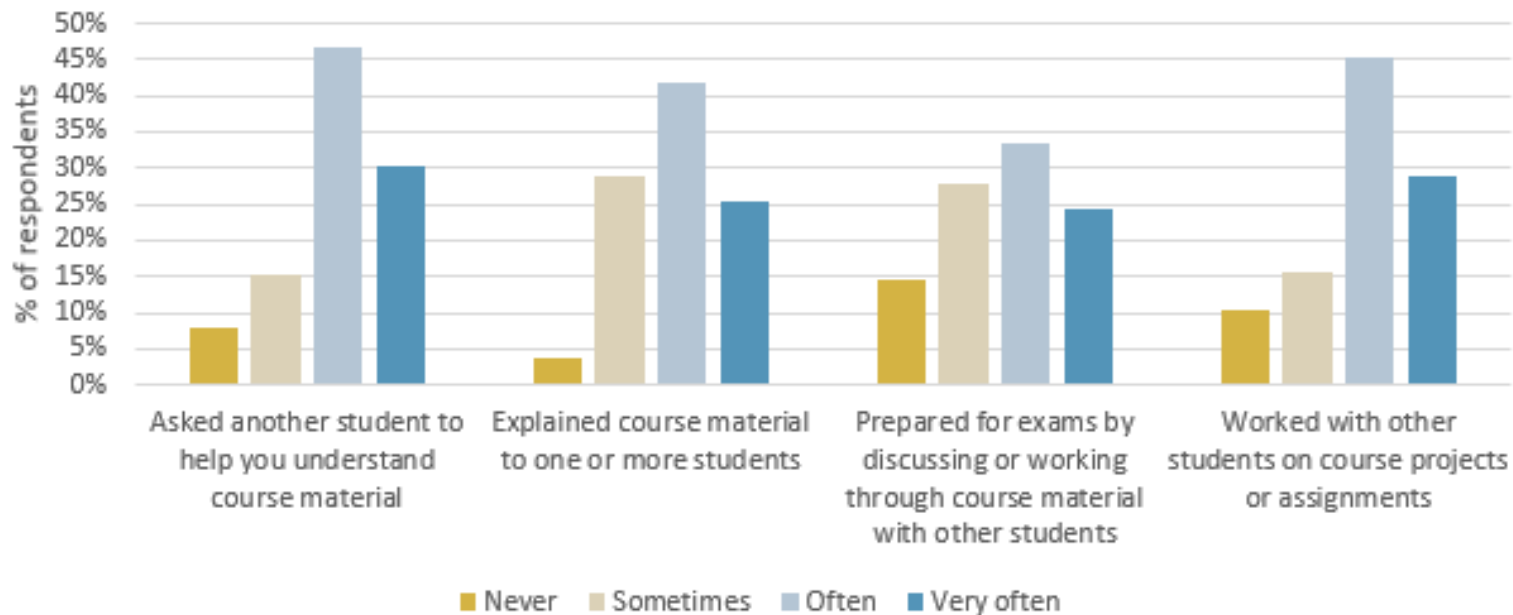
Version 3

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

0%   20%   40%   60%   80%   100%   120%

% of respondents

■ Never   ■ Sometimes   ■ Often   ■ Very often
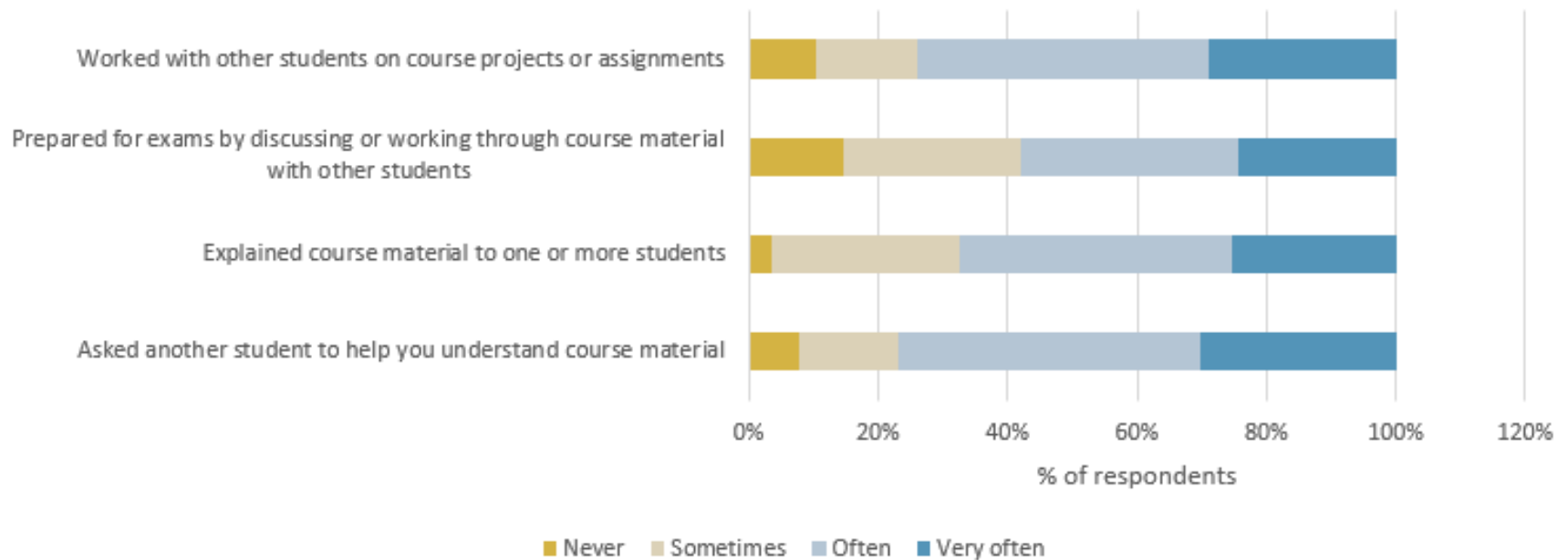
Version 4

Collaborative Learning
During the current school year, how often have you done the following?
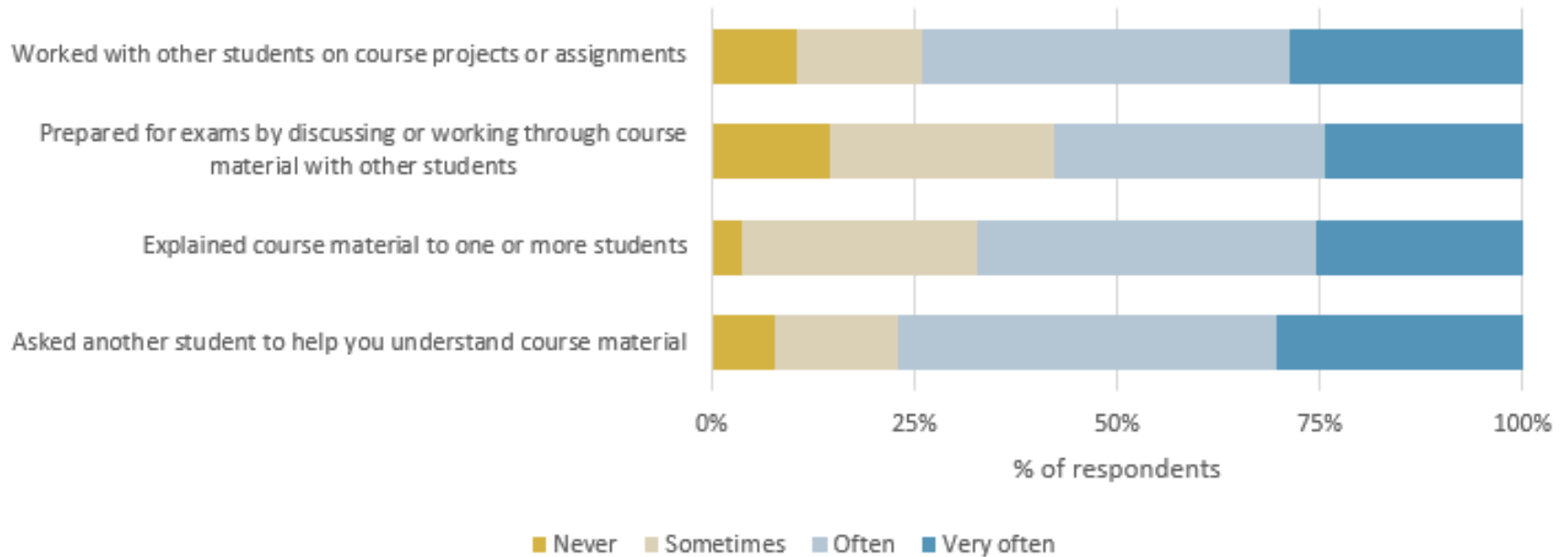
Version 5

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

	Never	Sometimes	Often	Very often
Worked with other students on course projects or assignments	10%	16%	45%	29%
Prepared for exams by discussing or working through course material with other students	14%	28%	33%	24%
Explained course material to one or more students	4%	29%	42%	25%
Asked another student to help you understand course material	8%	15%	47%	30%

% of respondents

■ Never   ■ Sometimes   ■ Often   ■ Very often
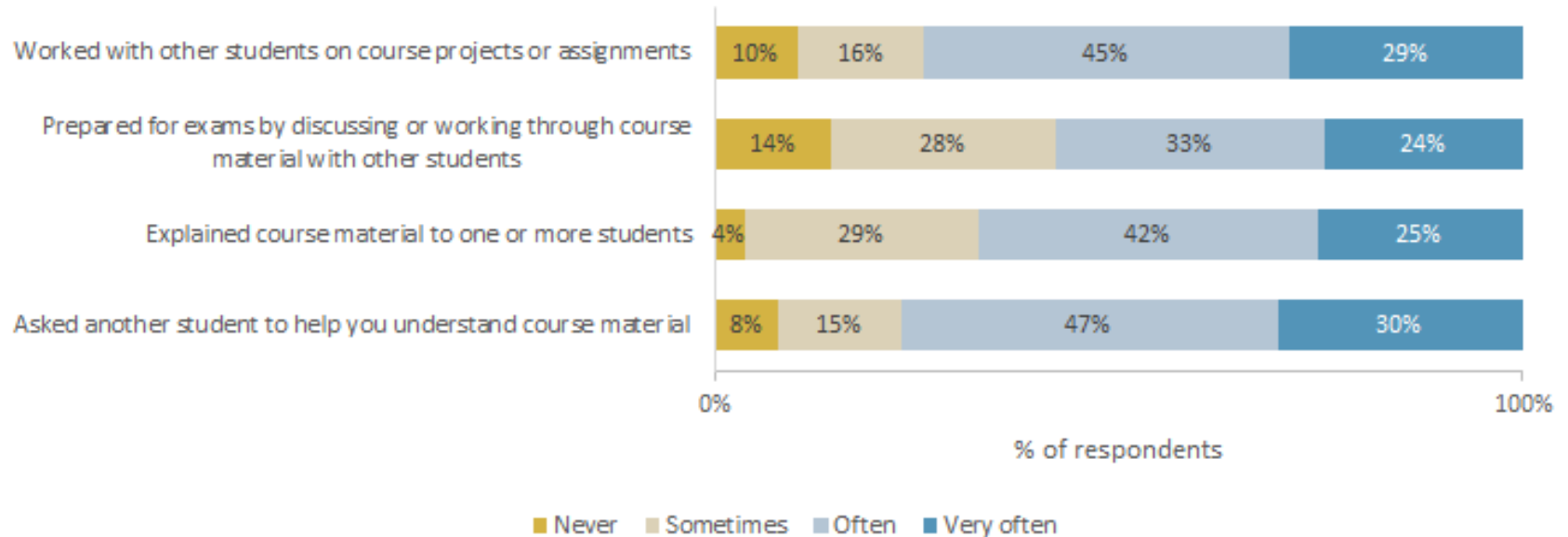
Version 6

Collaborative Learning

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

Statement	Never or Sometimes	Often or Very Often
Worked with other students on course projects or assignments	26%	74%
Prepared for exams by discussing or working through course material with other students	42%	58%
Explained course material to one or more students	33%	67%
Asked another student to help you understand course material	23%	77%

% of respondents

■ Never or Sometimes   ■ Often or Very Often

Version 7

Collaborative Learning

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

	Never or Sometimes	Often or Very Often
Prepared for exams by discussing or working through course material with other students	42%	58%
Explained course material to one or more students	33%	67%
Worked with other students on course projects or assignments	26%	74%
Asked another student to help you understand course material	23%	77%

% of respondents

■ Never or Sometimes   ■ Often or Very Often

Focus on respondents
who answered negatively

Version 7

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

Prepared for exams by discussing or working through course material with other students	42% / 58%
Explained course material to one or more students	33% / 67%
Worked with other students on course projects or assignments	26% / 74%
Asked another student to help you understand course material	23% / 77%

% of respondents

■ Never or Sometimes ■ Often or Very Often

Focus on respondents who answered negatively

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

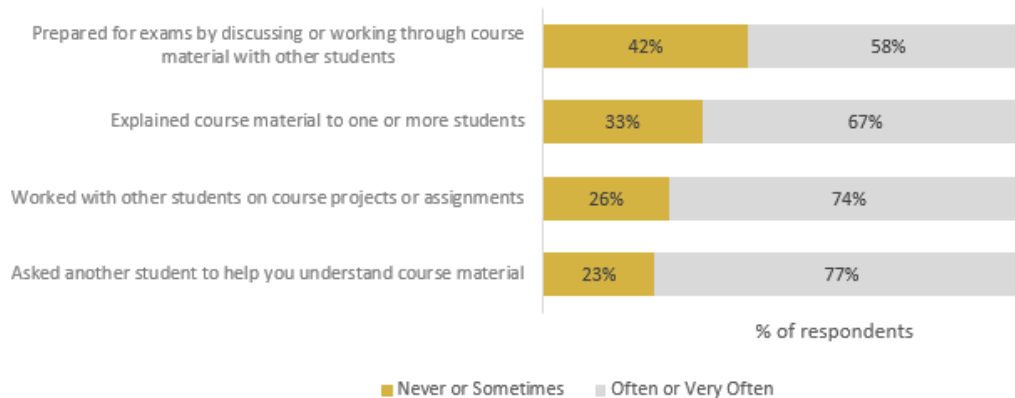|	
Asked another student to help you understand course material	77% / 23%
Worked with other students on course projects or assignments	74% / 26%
Explained course material to one or more students	67% / 33%
Prepared for exams by discussing or working through course material with other students	58% / 42%

% of respondents

■ Often or Very Often ■ Never or Sometimes
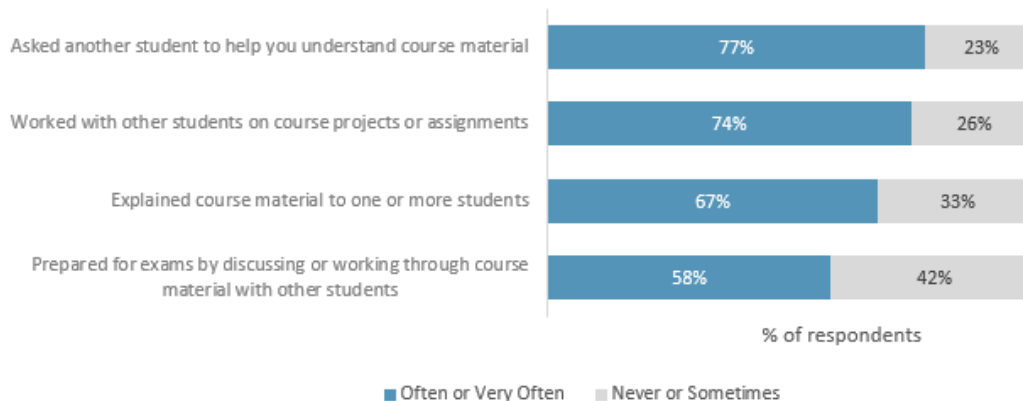
Focus on respondents who answered positively

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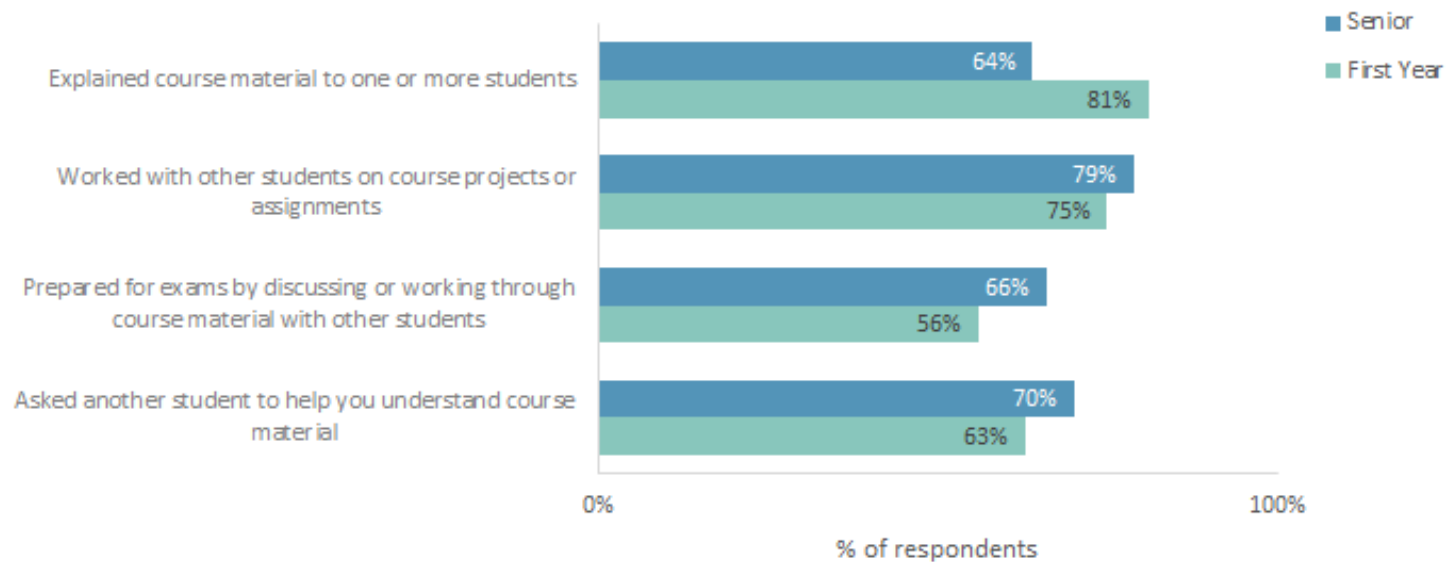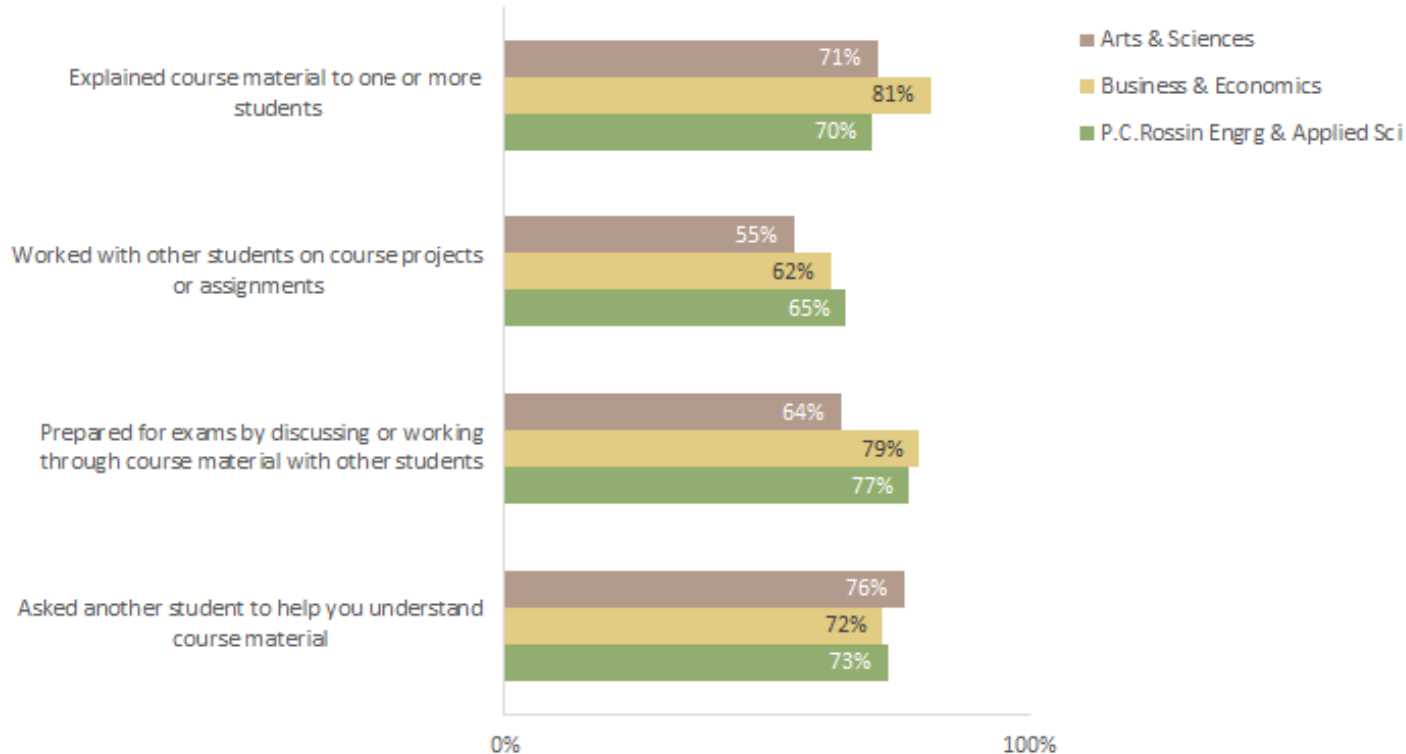(% of respondents who answered "Often" or "Very Often")

Legend: ■ Senior ■ First Year

Explained course material to one or more students — Senior 64%, First Year 81%

Worked with other students on course projects or assignments — Senior 79%, First Year 75%

Prepared for exams by discussing or working through course material with other students — Senior 66%, First Year 56%

Asked another student to help you understand course material — Senior 70%, First Year 63%

X-axis: 0% to 100% — % of respondents

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")

Legend:
- Arts & Sciences
- Business & Economics
- P.C.Rossin Engrg & Applied Sci

Explained course material to one or more students
- 71%
- 81%
- 70%

Worked with other students on course projects or assignments
- 55%
- 62%
- 65%

Prepared for exams by discussing or working through course material with other students
- 64%
- 79%
- 77%

Asked another student to help you understand course material
- 76%
- 72%
- 73%

0%   100%

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")
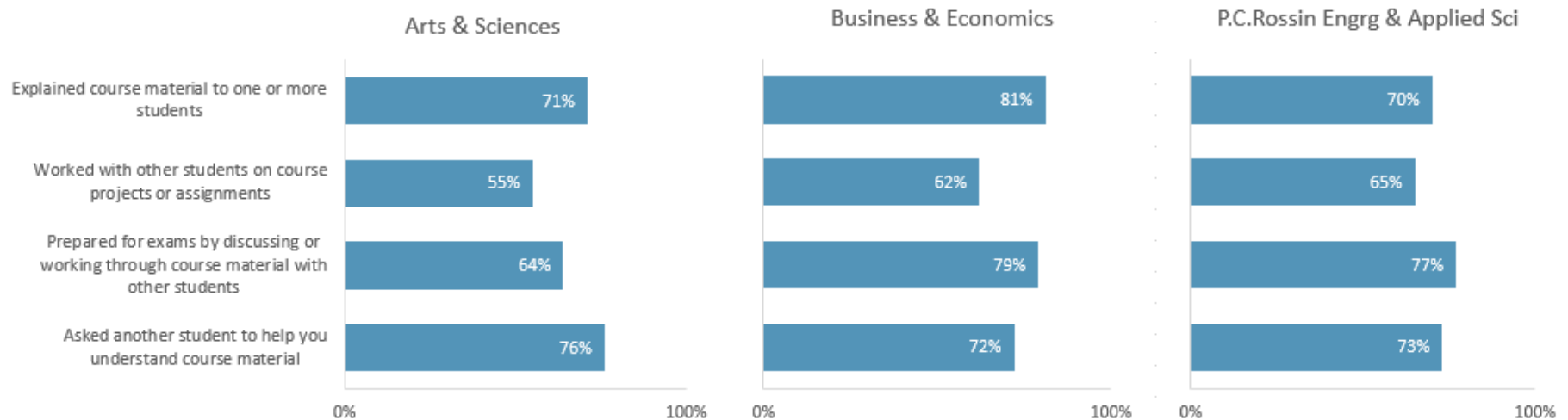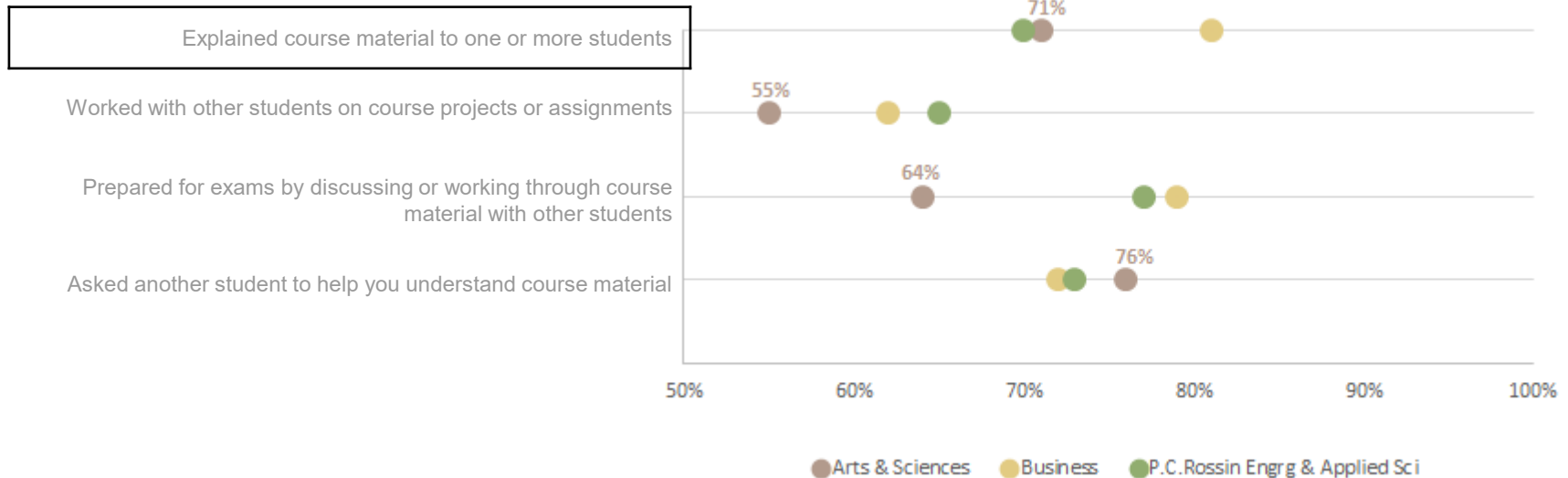
Multiple categories - option 3

Dot Plot: Encode the value using position instead of length. The axis doesn't have to start at 0, which can allow to see more variation in the data.

Collaborative Learning

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

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

Multiple categories - option 4

Heat Map: keep the data in a table format, but use color to encode the values.

Collaborative Learning

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

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

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

Example 3 - Longitudinal analysis

Survey: NSSE 2009, 2012, 2015 and 2018.
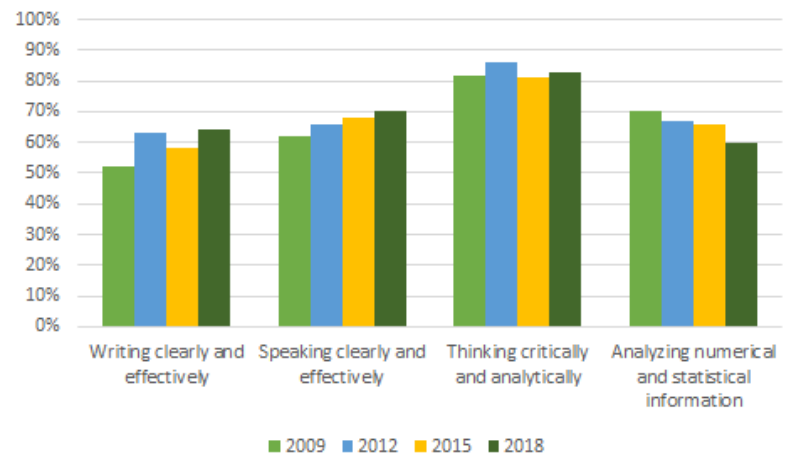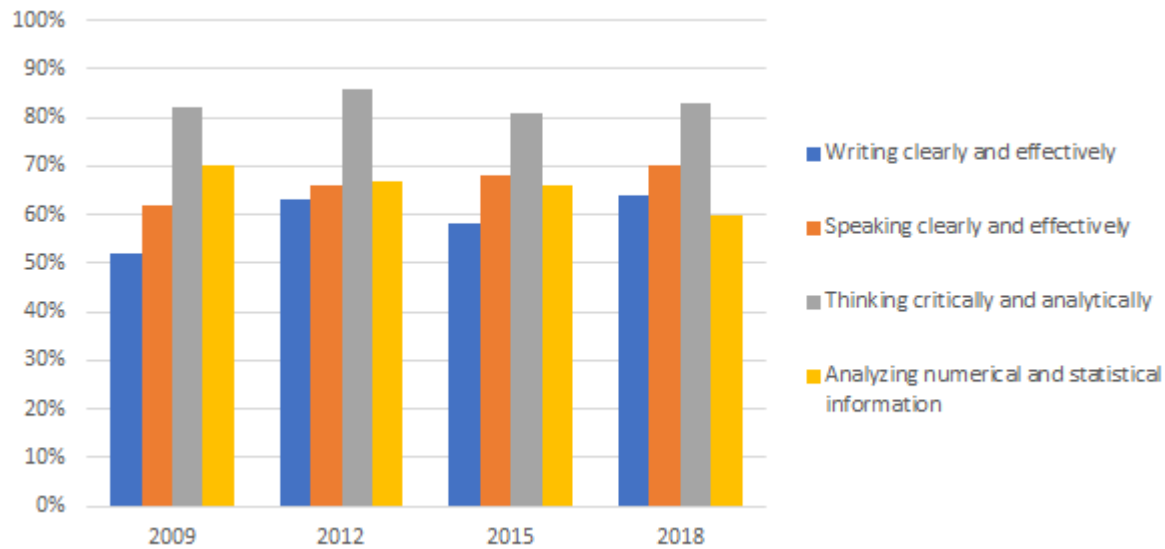
Topic: Perceived Gains

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

Version 2

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

Speaking clearly and effectively

Thinking critically and analytically

Analyzing numerical and statistical information
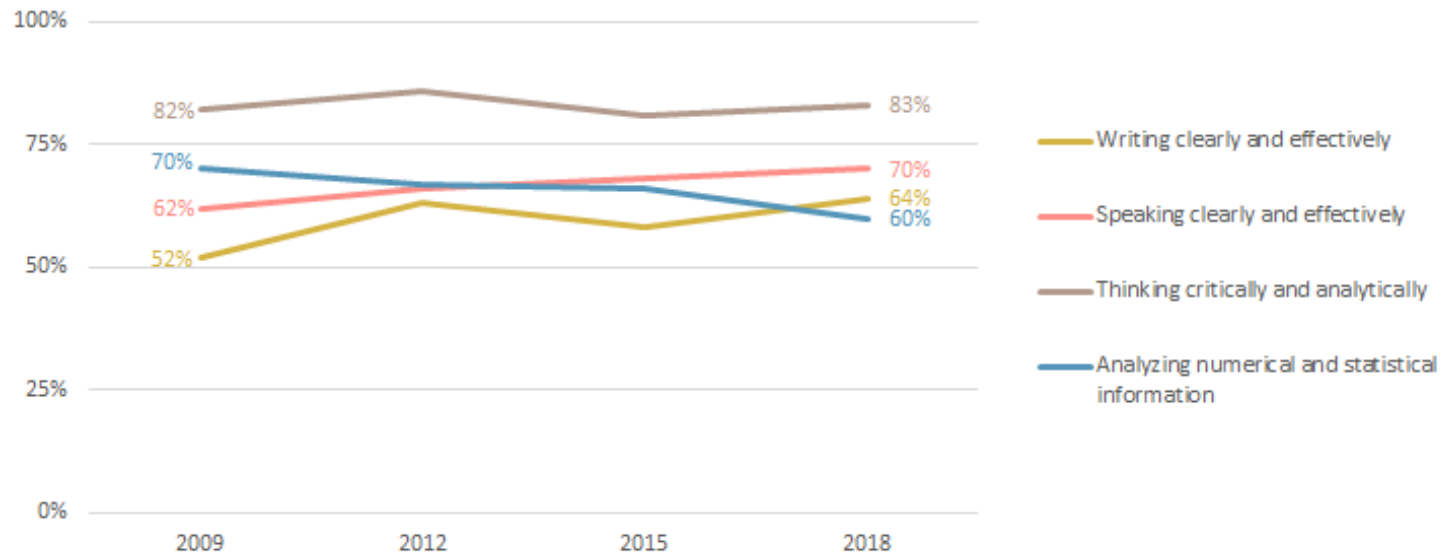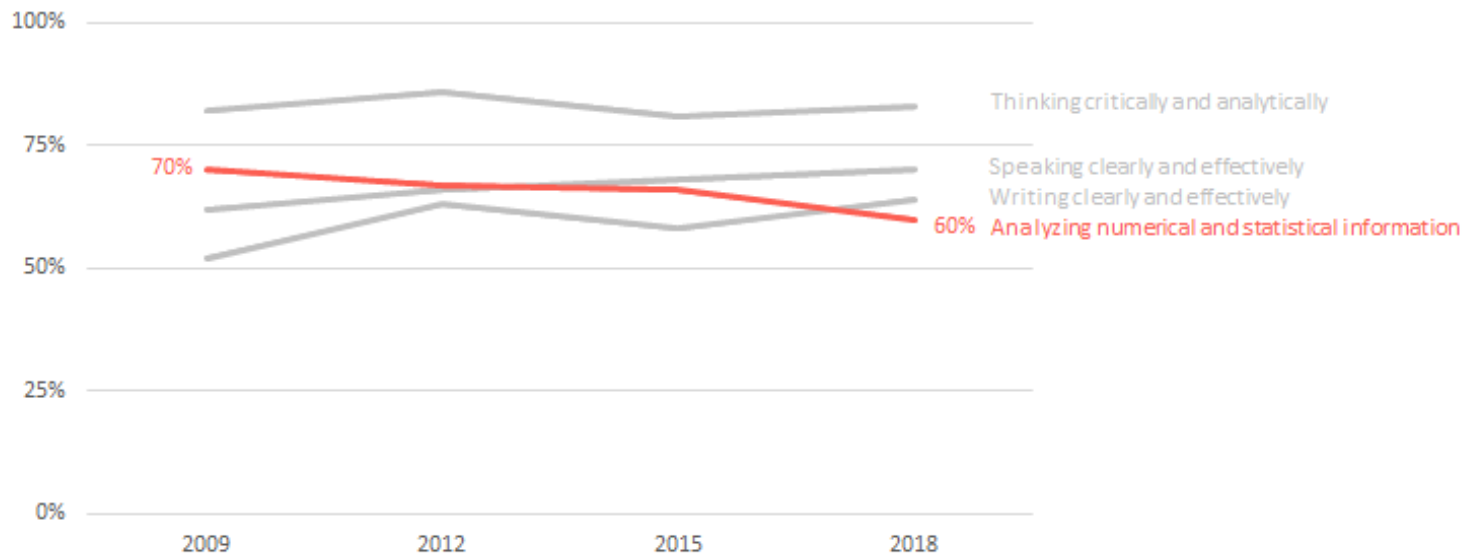
Version 3

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")

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

Sources

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

The big book of dashboards : visualizing your data using real-world business scenarios by Steve Wexler, Jeffrey Shaffer, Andy Cotgreave.

Cleveland, William S., and Robert McGill. "Graphical Perception and Graphical Methods for Analyzing Scientific Data." *Science*, vol. 229, no. 4716, 1985, pp. 828–833. *JSTOR*, www.jstor.org/stable/1695272. Accessed 7 Jan. 2020.

Tapping the Power of Visual Perception, Stephen Few, 2004.
https://www.perceptualedge.com/articles/ie/visual_perception.pdf

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

Questions?