

HEQCO Learning Outcomes Project: Electrical & Computing Engineering

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THE HIGHER EDUCATION QUALITY COUNCIL¹, created a consortium of three Universities and three Colleges in Ontario, and tasked them with determining methods for assessing broad, high-level learning outcomes across an institution. The Queen's Learning Outcomes Project², is a four-year longitudinal study that is looking at methods to assess cognitive skills, such as Critical Thinking, Problem Solving, Written Communication and Lifelong Learning, in the Faculty of Arts and Science and the Faculty of Engineering and Applied Science. There are a number of participating departments in both Faculties:

¹ <http://www.heqco.ca>

² <http://www.queensu.ca/qloa/home>

- Department of Drama
- Department of Psychology
- Department of Physics
- All 10 Departments in the Faculty of Engineering and Applied Science.

The project tracks the 2013-2014 cohort of students as they progress through their undergraduate experience at Queen's, to investigate how students develop these skills over the duration of their undergraduate education and to determine the efficacy, efficiency and sustainability of each assessment method.

The results from the project offer a means of triangulating results from other assessment instruments, such as the National Survey of Student Engagement or Queen's Graduate Exit Survey, and offer evidence towards demonstrating student performance in CEAB's graduate attributes or the Council of Ontario Universities Degree Level Expectations. This document presents a brief summary of each of the instruments, and a summary of the results for the Department of Electrical and Computing Engineering.

Assessment Tools

The Queen's Learning Outcomes Project is using four tools to assess cognitive skills:

- Standardized Instruments (The Collegiate Learning Assessment Plus and the Critical Thinking Assessment Test)
- Program level meta-rubrics (The Valid Assessment of Learning in Undergraduate Education or VALUE Rubrics)
- Qualitative Surveys (The Transferrable Learning Orientations Survey)

*The Collegiate Learning Assessment Plus (CLA+)*³

³ <http://cae.org/>

The CLA+ is a 90 minute, standardized test that students take online. The CLA+ is divided into two main tasks, each which are designed to measure a specific skills and abilities. The first is a Performance task, in which students are placed in a scenario and are given a library of evidence. They are asked to thoroughly read the evidence and then prepare their response for the scenario, which often has them support or refute a position or provide recommendations for potential action. This section of the instrument measures students abilities in analytic reasoning and problem solving, writing mechanics and writing effectiveness.

The second section of the CLA+ is a series of Selected-response questions, in which students are presented with a prompt and then asked to select a suitable response from the options provided. The questions ask students to evaluate claims, critique arguments, and interpret information. This section of the instrument measures scientific and quantitative reasoning, critical reading and evaluation and the ability to critique an argument.

Interpreting CLA+ Scores

The instrument is machine-scored, supplemented and checked by expert raters. The results are presented as a set of absolute criterion referenced scores and subscores as well as a set of norm-referenced Mastery levels⁴.

⁴ http://cae.org/images/uploads/pdf/cla_ss.pdf

To better understand how to interpret the scores, consider the following. Think of the absolute scores (Total Score, Performance Task Score, Selected Response Score) as the comparative measure of the student to use their skills in concert, in a realistic setting. The Mastery levels describe the characteristics and abilities, while the sub-scale scores measure how well the student performs in each specific skill. You can have a student display excellent analytical rea-

soning and problem solving, but poor written communication. This would be reflected by a high sub-scale score for analytical reasoning, poor for writing mechanics and effectiveness; producing a moderate Performance Task Score and lowering the overall total score.

*The Critical Thinking Assessment Test (CAT Test)*⁵

⁵ <http://www.tntech.edu/cat>

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Interpreting CAT Scores

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⁶ http://cae.org/images/uploads/pdf/cla_ss.pdf

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Margin Figures

Images and graphics play an integral role in Tufte's work. To place figures or tables in the margin you can use the `fig.margin` knitr chunk option. For example:

```
library(ggplot2)
qplot(Sepal.Length, Petal.Length, data = iris,
      color = Species)
```

Note the use of the `fig.cap` chunk option to provide a figure caption. You can adjust the proportions of figures using the `fig.width` and `fig.height` chunk options. These are specified in inches, and will be automatically scaled down to fit within the handout margin.

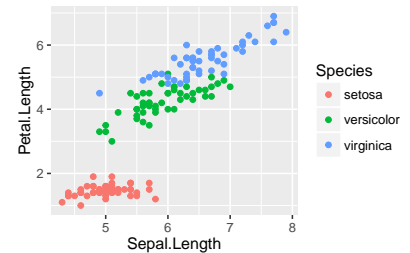


Figure 1: Sepal length vs. petal length, colored by species

Equations

You can also include \LaTeX equations in the margin by explicitly invoking the `marginfigure` environment.

Note the use of the `\caption` command to add additional text below the equation.

$$\frac{d}{dx} \left(\int_0^x f(u) du \right) = f(x).$$

Figure 2: An equation

Full Width Figures

You can arrange for figures to span across the entire page by using the `fig.fullwidth` chunk option.

```
qplot(wt, mpg, data = mtcars, colour = factor(cyl))
```

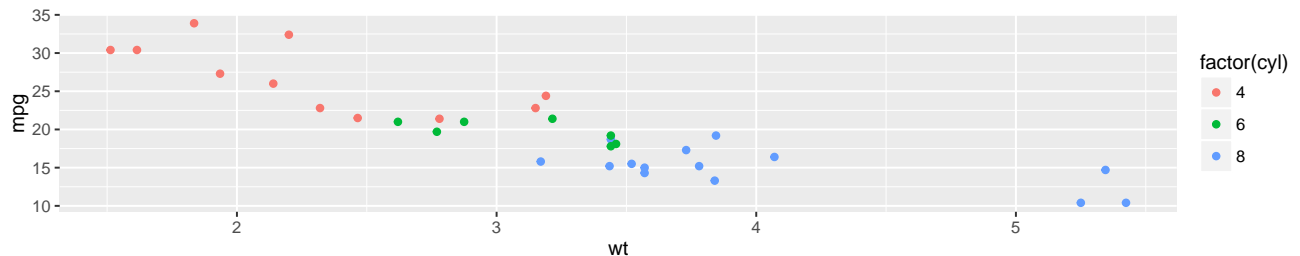


Figure 3: Full width figure

Note the use of the `fig.width` and `fig.height` chunk options to establish the proportions of the figure. Full width figures look much better if their height is minimized.

Main Column Figures

Besides margin and full width figures, you can of course also include figures constrained to the main column.

```
qplot(factor(cyl), mpg, data = mtcars, geom = "boxplot")
```

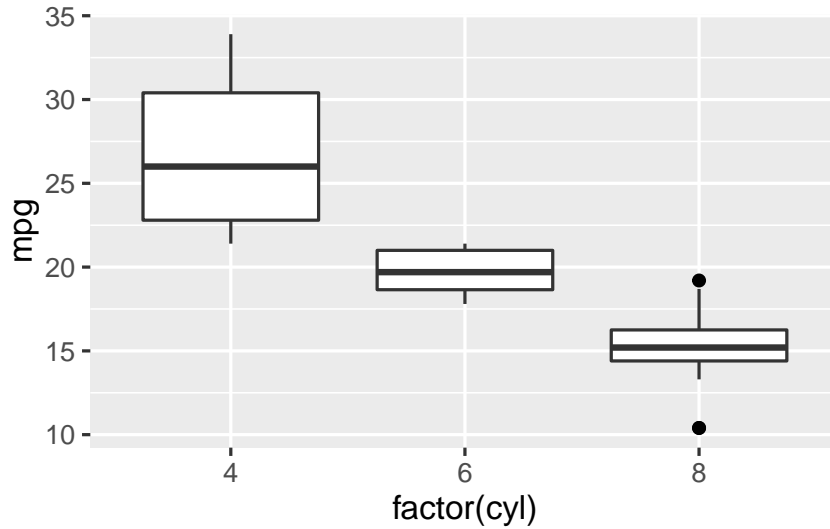


Figure 4: Another figure

Sidenotes

One of the most prominent and distinctive features of this style is the extensive use of sidenotes. There is a wide margin to provide ample room for sidenotes and small figures. Any use of a footnote will automatically be converted to a sidenote.⁷

If you'd like to place ancillary information in the margin without the sidenote mark (the superscript number), you can use the `\marginnote` command.

Note also that the two footnote references (`tufte_latex` and `books_be`, both defined below) were also included in the margin on the first page of this document.

⁷ This is a sidenote that was entered using a footnote.

This is a margin note. Notice that there isn't a number preceding the note.

Tables

You can use the `xtable` package to format \LaTeX tables that integrate well with the rest of the Tufte handout style. Note that it's important to set the `xtable.comment` and `xtable.booktabs` options as shown below to ensure the table is formatted correctly for inclusion in the document.

```
library(xtable)
options(xtable.comment = FALSE)
options(xtable.booktabs = TRUE)
xtable(head(mtcars[, 1:6]), caption = "First rows of mtcars")
```

	mpg	cyl	disp	hp	drat	wt
Mazda RX4	21.00	6.00	160.00	110.00	3.90	2.62
Mazda RX4 Wag	21.00	6.00	160.00	110.00	3.90	2.88
Datsun 710	22.80	4.00	108.00	93.00	3.85	2.32
Hornet 4 Drive	21.40	6.00	258.00	110.00	3.08	3.21
Hornet Sportabout	18.70	8.00	360.00	175.00	3.15	3.44
Valiant	18.10	6.00	225.00	105.00	2.76	3.46

Table 1: First rows of mtcars