



FYMSiC Online Teaching Meet Up

Technology Show and Tell

by Ana Duff
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Using Open Data in First Year Math

Open data

What is open data?

European Data Portal: Open data is **data** that **anyone** can **access, use** and **share**. Governments, businesses and individuals can use open data to bring about social, economic and environmental benefits.

Many open data sources, and growing:

- Open Canada (open.canada.ca); Open Data (open.canada.ca/en/open-data)
- Open Toronto (open.toronto.ca)
- EU Open Data (data.europa.eu/euodp/en/data)
- ...

Dataset Filters

Topic

- Locations and mapping
- City government
- Community services
- Transportation
- Development and...
- Show 10 more topics

133

126

79

77

44

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Using open data to provide meaning to first year math

Typical first-year university math course:

- Purpose: to equip students with the foundational knowledge and skill in higher-level algebra and study of functions (calculus) to support a wide range of higher-level courses within the chosen discipline
- Typically quite abstract (as is required in order to gain mastery of the required skills)
 - Hard for students to motivate; seeming lack of connection to their discipline breeds resentment, frustration
 - Effect can be reduced through hands-on applications to real-life problems
 - Open data provides avenue to creating such opportunities (current issues, different perspectives, reliable/curated sources)

Challenges in creating learning opportunities using open data:

- Applicability to math learning outcomes
- Reading and comprehension of written materials using technical language
- Learning curve associated with technology tools used to analyze and interpret data
- “Hand-waving” due to students’ lack of knowledge and skills related to statistical methods



Examples

Overall learning objectives: understanding data and information related to data; using mathematical functions and critical thinking skills in modeling the given data and making predictions; using technology in data analysis

1. Modeling Canadian household mobile subscription data

- First year calculus (business and IT streams); large, independent project; minimal technology skills required; primary technological tool: Desmos graphing calculator (online, free access)
- Math learning outcomes focused on: basic function types and their characteristics, transformations and products of functions, limits at infinity, evaluations of functions, and differentiation of functions and rates of change

2. Modeling data using linear relationships: CPI and earnings over time

- First year business math; large, independent project; minimal technology skills required; primary technological tool: Microsoft Excel
- Math learning outcomes focused on: indexes as measures of change, linear relationships and their characteristics, rates of change as descriptors of trends



Modeling Canadian household mobile subscription data

Step 1: Sourcing the data

Sourcing the data

1. Retrieving the data

- a. Using a web browser, locate the Canadian Radio-television and Telecommunications Commission's *Communications Monitoring Report 2018 on Communications Services in Canadian Households: Subscriptions and Expenditures 2012-2016*. Briefly (in one to three sentences) state what the report is about and include the website address.
- b. Read Quick Facts and briefly state what they say about trends in household communication services subscriptions.
- c. Read the summary on what communication services Canadian households use and briefly state what additional trends are identified.
- d. On the webpage, follow the Government of Canada - Open Publication and the published information.
- e. State the licence under which you are allowed to use the data and briefly why you are allowed to use it.
- f. Download the XLSX file containing the data and save it to your computer. The file is located here: [Households Subscriptions and Expenditures 2012-2016](#).

2. Understanding the data

- a. Download the data dictionary (DOCX or TXT format) and read it.
- b. Review the information in Table 1.1 and explain what the data is describing.
- c. What are the input values and the output values, and their units of measurement?
- d. What appear to be trends in the data, if any? Are there any holes or inconsistencies in the data and, if yes, how can they be explained?
- e. Select the rows and columns containing the data (including the headings) and use the Excel Charts tool to create a scatter plot of the data. Give it a title, add axis titles and copy it here.
- f. Briefly provide your prediction for each of the categories as many years pass. Which mathematical concept describes this process?

Understanding and getting the feel of the data:

- **data source:** what is the background behind the data and what are the restrictions of use, if any (contextual, technical, proprietary)
- **existing information:** what did others learn by looking at the overall data?
- **the first big picture:** what can we, at the first glance, tell from the data tables and scatter plots about the trends in Canadian household mobile subscription rates?

Math concepts:

- Input and output variables
- Trends and rates of change
- Limits



Modeling Canadian household mobile subscription data

Step 2: Modeling the data for household mobile subscription rates

3. Choosing the model

- Create a new Excel spreadsheet containing the Mobile subscription data from Table 1.1. Change the Year column heading to Years since 2004 and update the data in the column accordingly.
- Open a new graph in the Desmos Graphing Calculator and copy the data into the first line. Rename the independent and dependent variable in the Desmos table to t_1 and M_1 , respectively. Using the Graph Settings tool (wrench icon in top right corner), add arrows and export and insert the image of the resulting graph below, resizing it to 2" in height.

4. Creating the model function using regression

- Go to Help tool (? icon) and run the Regression Tour. If needed, go to Video Tutorials and watch a video on Regressions.
 I completed the Regression Tour (check the box to confirm)
- Using what you learned about creating the regression models using Desmos, create the regression model using the type of function you chose above. Using the Share Graph tool (top right corner), export and insert the image of the resulting graph below, resizing it to 2" in height.
- Using the regression function parameters given by Desmos, write below the function $M(t)$ represented by that regression model.
- Does this model provide a reasonable model for the data and why?
- Using the Share Graph tool (top right corner), copy below the link to your graph.

Fitting a model to data:

- trends:** when plotted on a graph, what do the data points tell us about the overall trends in household mobile subscription rates?
- regression tools:** how can we use technology to help us find curves of best fit?

Math concepts:

- Basic function types
 - Algebraic representation
 - Fundamental characteristics
 - Visual representation (graphs)
- Transformations of functions
- Regression: linear and non-linear

Modeling Canadian household mobile subscription data

Step 2: Modeling the data for household mobile subscription rates (continued)

5. Adjusting the model as necessary by considering context

- Do you think that, over time, all of the Canadian households will have a mobile subscription, and why? Make a prediction for % of households that will have a mobile subscription as years pass.

6. Adjusting the model as necessary by considering additional information

- Looking at the subscription prediction using the model, which prediction is more accurate?
 - Which prediction is more accurate?
 - Recreate the right corner in height.
 - Does the agreement between the two models change?
 - If applicable, and write down the new formula for $M(t)$.
 - Using the Share Graph tool (top right corner), copy below the link to your graph.
- Consider the data on household mobile subscriptions prior to 2004. Download the data from the 1997 – 2009 Survey of household spending on household equipment from [Open Canada](#). Open the CSV file and use the following filters (Data – Filter Excel tool) to return:
 - GEO: Canada
 - Household
 - UOM: PercentageCopy the resulting data into the spreadsheet.
 - Does this data appear to model well the expanded data set? Briefly explain your reasoning.
 - Create a new regression model that incorporates the expanded data set and models your prediction for mobile subscription rates as years pass. Using the Share Graph tool (top right corner), export and insert the image of the resulting graph below, resizing it to 2" in height.
 - Consider the history of cellular phone use, particularly in Canada, by reading [Complete Visual History of Cellphones](#) and [Cellphones mark 30 years in Canada](#). Which of the two models you created would be a better reflection of the trends since the introduction of mobile phones to Canadian society, and why?
 - If applicable, change the parameters in $M(t)$ to reflect the revised regression model and your [long term](#) predictions, and write the new formula for $M(t)$ below.
 - Using the Share Graph tool (top right corner), copy below the link to your graph.

Adjusting the model:

- the context:** does the model reasonably represent what you expect in terms of long term trends in household mobile subscriptions?
- additional information:** if additional information were to be considered, such as additional data, would it be beneficial to adjust the current model to include the additional info?

Math concepts: limits at infinities



Modeling Canadian household mobile subscription data

Step 3: Making predictions

7. Household mobile subscription rates

- a. Using the model you developed for household mobile subscription rates, predict the percentage of households that will have a mobile subscription in year 2025, in 2030

8. Modeling the number of households with mobile subscriptions

- a. To obtain the data on number of Canadian households over years since 2004, follow the link to the Statistics Canada data on [Distributions of household economic](#)
- b. What does $H(t)$ tell you about the rate of change in the number of Canadian households?
- c. Using your models $M(t)$ and $H(t)$ for the household mobile subscription rates and the number of Canadian households, determine the function $H_M(t)$ modeling the number of Canadian households with a mobile subscription t years from 2004. Write $H_M(t)$ below.
- d. Using the model $H_M(t)$ for the number of Canadian households with mobile subscriptions t years from 2004, predict the number of households that will have a mobile subscription in years 2025 and 2030. Show your calculations.
- e. What are the projected rates of change in the number of households that will have a mobile subscription in 2025 and 2030? Show your calculations and interpret the results.
- f. Suppose that, due to new technology developments in communications, the household mobile subscription rate in 2050 is 95% and is decreasing at the rate of 5% per year. Suppose further that the number of Canadian households continues to grow at the same rate as today. Find the rate of change in the number of households with a mobile subscription in 2050. Show your calculations and interpret the result.

Extending:

- **going beyond the data:** what does the model tell us, in the short term and in the long term, about the mobile subscription rates and the trends?
- **reality checks:** to what extent can we rely on this model to make long-term predictions, given historical and other contexts?
- **combining data to learn more:** what can we learn by combining the data on the number of Canadian households with the data on Canadian household mobile subscription rates?

Math concepts:

- Evaluations of functions
- Rates of change and differentiation
- Differentiation rules: product rule
- Related rates

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2. Modeling data using linear relationships: CPI and earnings over time

- First year business math; large, independent project; minimal technology skills required; primary technological tool: Microsoft Excel
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Modeling data using linear relationships: CPI and earnings over time

PREPARATION TASK:
Create a Word document titled BUSI1915Week6ActivityNotes. Use this document to write down your notes at

TASK 1: Finding and investigating the data

1) Getting the data – create the data spreadsheet

2) Visualizing the data

3) Making sense of the data

TASK 2: Modeling the CPI data using linear regression

1) Creating the chart

TASK 3: Changes in earnings per industry

1) Getting the data – create the data spreadsheet

2) Visualizing the data

3) Making sense of the data

TASK 4: Weekly earnings and inflation

1) Creating earnings index data – calculate weekly earnings indexes

2) Visualizing the data – plot the earnings index data on a graph

3) Making sense of the data – write down your observations. For example:

4) Modeling the data using linear regression

5) Making sense of the models - write down your observations. For example:

Steps:

- **background:** why do indexes matter in business and commerce?
 - **obtaining and making sense of processed data:** what do data tables and the scatter plots tell us about the trends in the Canadian consumer price index and the average weekly earnings of Canadians?
 - **modeling to make comparisons and predictions:** what does the visual representation of the data tell us about the best choice for model functions CPI and earnings indexes?
 - **extending:** how can the modeling of index data be useful to you, to the businesses and the economists, and to the Government of Canada?
- ## Math concepts:
- Ratios; indexes; real vs. nominal amounts
 - Input and output variables; linear relationships as linear functions: straight line vs. constant rate of change; initial value
 - Trends and rates of change



Wrap-up

Examples such as those presented above can be adapted or created anew for comprehensive projects and for short, quick in-class exercises by:

- using updated or new data sets,
- taking into account different use of technology, research, critical thinking and math-related levels of student skill,
- setting different learning objectives.

Things to consider:

- Student skill level
- Primary objectives and resulting scaffolding requirements
- Fit within the course learning objectives
- Teaming up with colleagues teaching other courses for cross-relevance

Project documents related to examples discussed in this presentation can be obtained free of charge by contacting Ana Duff at ana.duff@ontariotechu.ca.

