A Self-guided Workshop on Data Handling and Analysis using Microsoft Excel [1]

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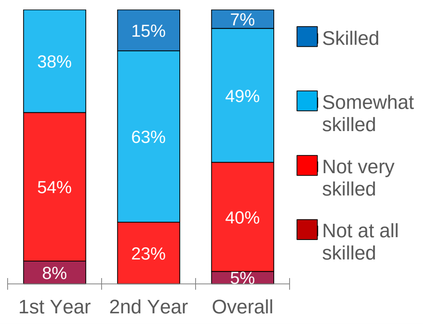
Introduction The worldwide COVID-19 pandemic is changing the landscape for university teaching significantly, including the delivery of practical teaching laboratories. Recognising the potential of resources that can be delivered online, we report a practical focused on developing the skills that accompany experimental laboratory work, namely, data handling, processing and analysis.[1]

Why Microsoft Excel?

- Data handling, processing and analysis are integral scientific skills
- Proficiency with Microsoft Excel is the most sought technical skill by UK (and US) employers at all skill levels[2]
- Visual interface with readily customisable graphics output
- Platform to introduce elements important to coding, e.g. formula syntax and layout of information
- Familiarity with the software enabled us to introduce new applications / capabilities of Microsoft Excel to students.

Identified Weakness

Our undergraduate practical course emphasises the development of skills. Despite repeated practice, data processing remained a relative weakness:
End-of-year student survey (1st year: n = 48; 2nd year, n = 40) indicated 45% of students identified as not being competent using Microsoft Excel.



Workshop Aims / Objectives

- Handling larger data sets
- Processing data using various formulae (logical, statistical, mathematical, trigonometric), including use of data-filling functionality
- Layout and presentation of data (cell formatting, graphical representation)
- Introduction to the use of the Solver add-in to optimise parameters
- Demystefying the behind-the-scenes processes performed by specialist software for data analysis (e.g. R, Origin, MestReNova); removing treatment of software as a 'black-box'
- Contextualisation of the analyses to scenarios relevant within chemistry.

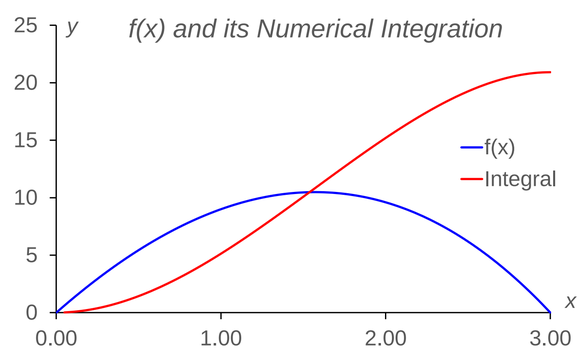
Tasks

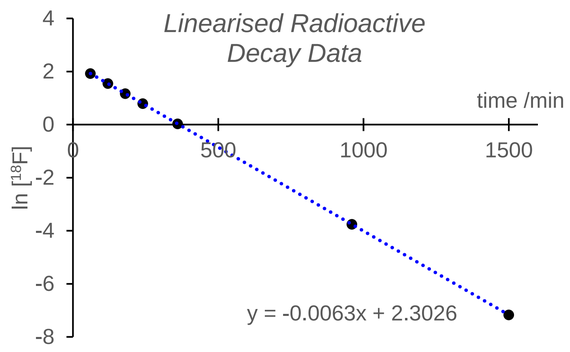
- Use of the quadratic formula to determine roots
- Use of Newton-Raphson root-finding algorithm to find numerical solutions to polynomials
- Use of Riemann summation for calculating the area under a curve
- Revision of linearisation of data and regression analysis
- Introduction to nonlinear curve fitting using the Solver algorithm
- Statistical analysis of the nonlinear curve fitting model
- Signal deconvolution of spectroscopic data (UV-vis and NMR) using nonlinear curve fitting models.

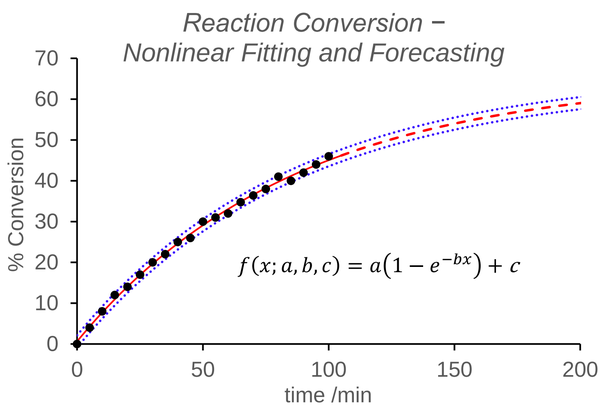
Example Processed Data

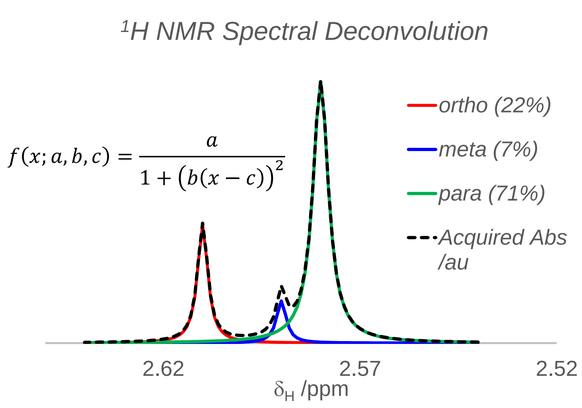
Below are selected output figures of the processed data for the tasks, including:

i) Numerical integration by Riemann summation
ii) Linearisation of data for regression analysis
iii) Nonlinear curve fitting, statistical analysis and model forecasting
iv) Deconvolution of spectra (using nonlinear curve fitting)



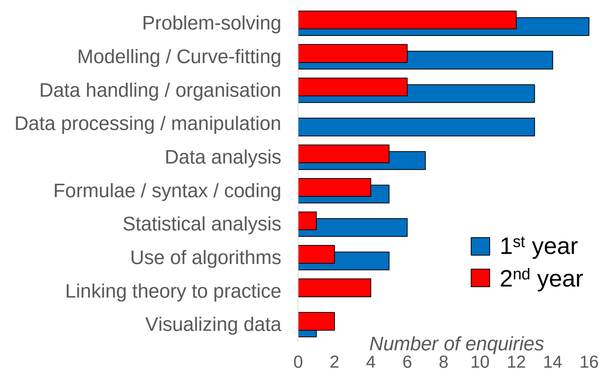






Remote Delivery

- Delivered remotely from March 2020 as a self-directed exercise.
- Completed by:
  130 1st year students
  138 2nd year students
- Communication provided primarily *via* email, with students attaching spreadsheets alongside their queries.
- Email responses generally had quick turn-around time (<20 min), depending on time of submission.
- Follow-up video chat (Microsoft Teams) were provided if requested.

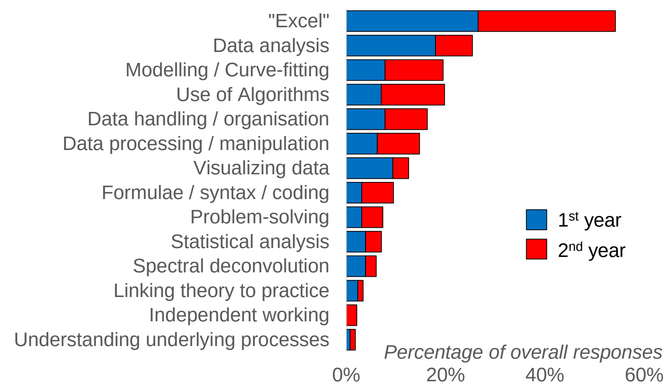


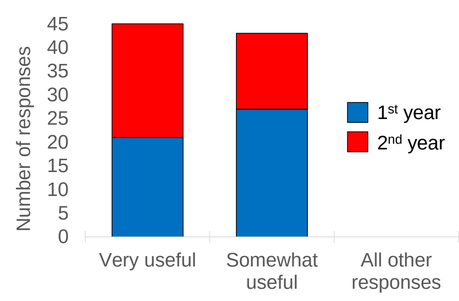
Students' queries (n = 122) were categorised into different areas, with problem-solving and the successful implementation of the Solver algorithm representing most queries.

Results and Student Feedback

Using thematic indexing, students (1st year: n = 48; 2nd year, n = 40) identified a wide range of skills being developed, including:

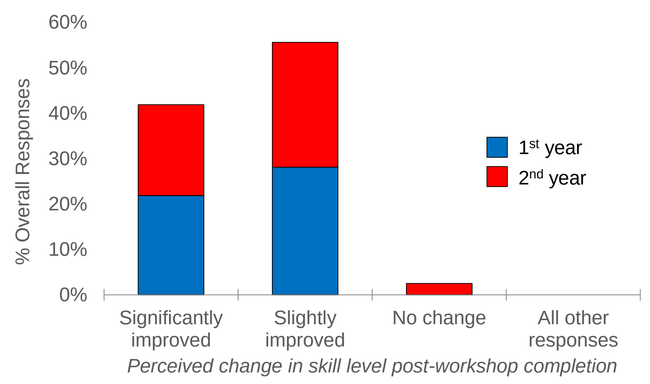
- using data to draw conclusions (25% of all responses)
- modelling/curve-fitting (20%)
- use of algorithms (20%)
- data handling (17%).

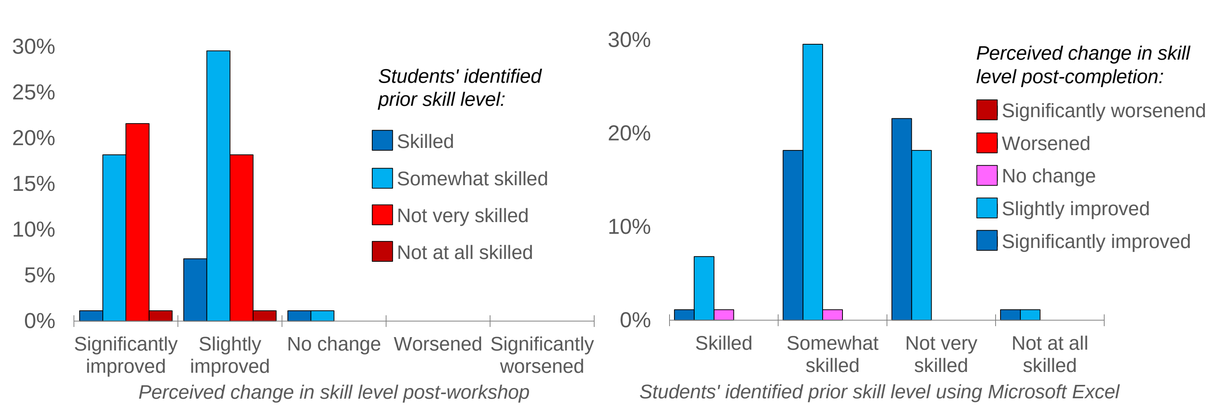




Students were asked about the usefulness of the workshop, using a four-point Likert scale. All students found the workshop useful, especially 2nd year students, who commented on seeing the application of the techniques introduced, and understanding the processes involved.

To evaluate the impact of the workshop, we asked students to identify their perceived change in skill level using Microsoft Excel upon completion of the workshop. Most encouragingly, the majority of students (98%) perceived that the workshop improved their Excel ability.





Conclusions Our new remotely delivered workshop has been successfully implemented during the COVID-19 pandemic. Student feedback has been very positive, reporting that the tasks are useful applications of Microsoft Excel. Importantly, students reported a significant general up-skilling and confidence in using the program. This will hopefully translate to improvement in efficiency for future data processing tasks.

References 1. *J. Chem. Educ.* Paper accepted, 24th July 2020.
2. "No longer optional: employer demand for digital skills", Burning Glass Technologies, 2019 (accessed online, August 2020).