Five interesting ways to integrate numeracy into vocational courses

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Introduction

Over a number of years, my colleagues and I at Coleg Meirion-Dwyfor have been investigating interesting ways of integrating numeracy into vocational courses at various levels from GCSE to Foundation Degree. We have found that student motivation for numeracy is increased by:

- Solving interesting problems which are relevant to the student's course
- Producing a product, either as an artefact or as a presentation or professional document
- Practical measurement, or the collection of primary data through surveys
- Autonomy in the specification and design of the learning activity
- Working with others as a team, developing and using the special skills of each member.

Activities incorporating a number of these features may arise naturally during course work. At Further Education level 1 or 2, students may be given the challenge of planning and running a small business enterprise, as an introduction to entrepreneurship. The business might produce craft work or food items for sale, or provide a service such as car washing. An important aspect of the project would be the careful costing of the required equipment, materials and workers' time, and the choice of appropriate customer prices for the product or service.

At a more advanced level is a project undertaken by our engineering students to develop a small wind turbine. This required accurate measurement techniques in the workshop, along with calculations for the design of the electrical components.

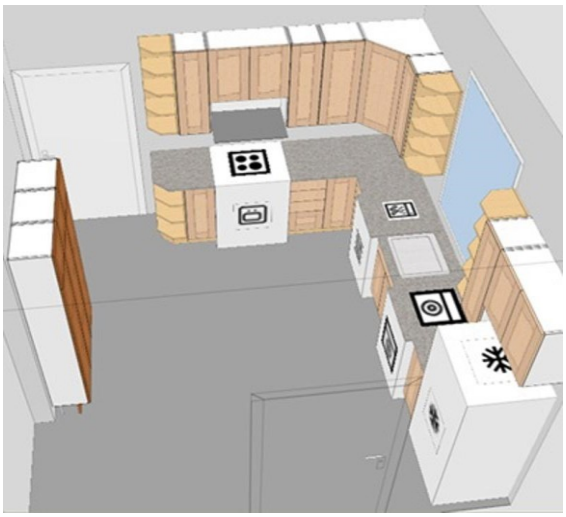
It is often the case, however, that the course tutor has to devise additional tasks to meet a requirement to improve student numeracy. A useful framework for introducing real world problems into mathematics teaching has been proposed by Tang, Sui, & Wang (2003) from their work with academic students in China. Our own practitioner research has focussed on ways in which this framework could be successfully adapted for embedding numeracy activities into vocational courses at further education level (Hall, 2014).

The five approaches identified by Tang et al. are: ***Extension***; ***Special Subject***; ***Investigation Report***; ***Paper Discussion***; and ***Mini Scientific Research***. These represent a progression from applications set by the teacher, through increasing student involvement in the solution of real world problems, to totally independent project work designed by students themselves. Examples for each approach are given below. Further details of the mathematics involved are included in the book '*Developing Numeracy in Further Education*' (Hall & Slaney, 2016), where full references to resource materials are given.

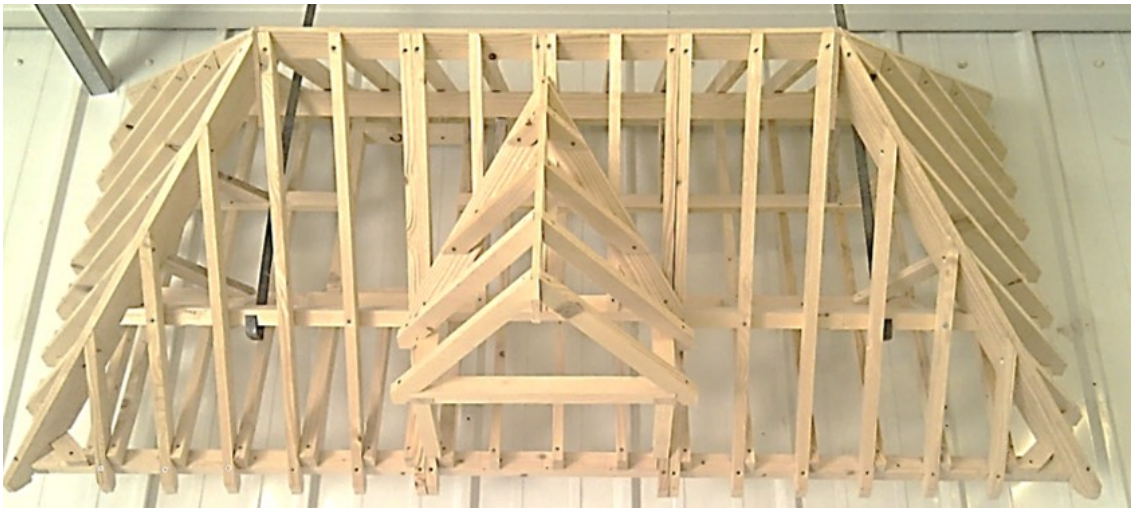
Extension

After learning a mathematical technique, students apply this to an ill-defined real-world problem. Students need to obtain their own additional data to solve the problem. The objective is to develop ***skills in the practical use of numeracy*** in a realistic context.

If we consider applications of shape and space, students at level 1 or 2 might be given a design for a kitchen, then asked to consult internet pages to find the costs of suitable furniture and appliances and calculate the quantities and costs of floor covering and wall tiles.



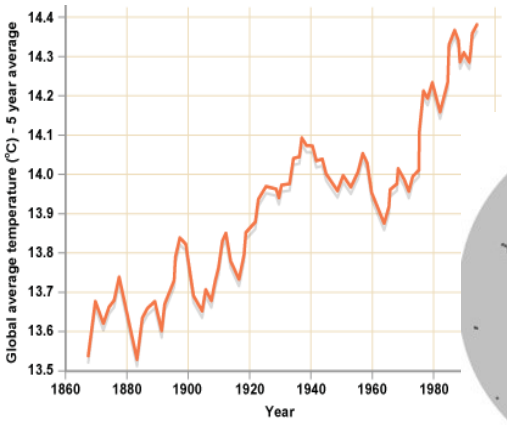
For a more advanced application, building students may learn about the construction of timber and slate roofs. After studying the roof structure, the group is given the challenge of designing a roof for a house of a specified size. Plans and elevations can be drawn by hand, or with the assistance of architectural computer aided design software.

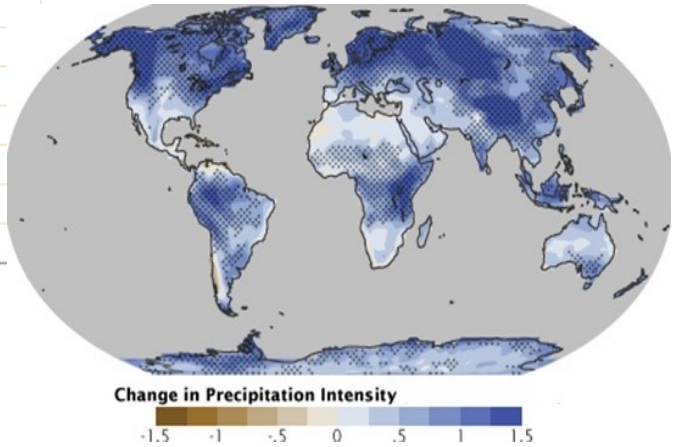


Special Subject

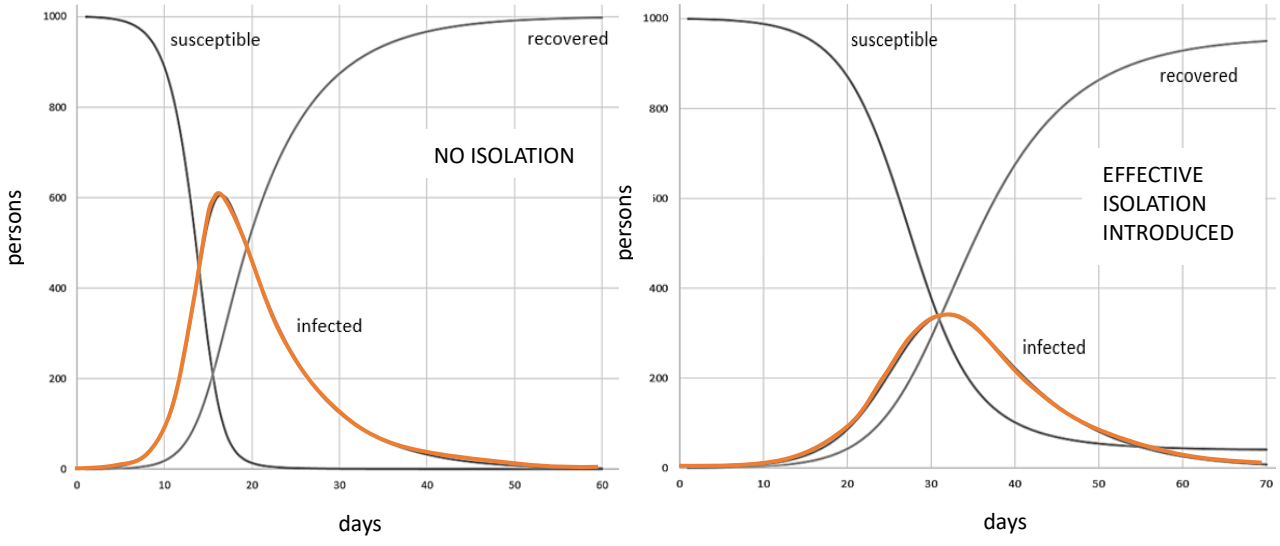
After studying a vocational topic, students explore the topic further using mathematical techniques. This leads to a deeper understanding, and provides evidence for critical analysis. The objective is to develop ***skills in mathematical modelling***.

At levels 1 or 2, students might carry out an investigation into the extent of climate change. This might involve use of the internet to gather data on: changing temperatures and rainfall patterns in different areas of the world and changes in sea level; and changes in the frequency of extreme weather events such as hurricanes, floods, and droughts. Students may then make predictions of future climate conditions if trends continue.





As a more complex example, health and social care students learn about the spread and control of epidemics of diseases. To further investigate the factors involved, we use a spreadsheet to model an epidemic such as influenza. Students can explore the effects of introducing early isolation for infected persons, or the effects of different levels of vaccination in the general population.



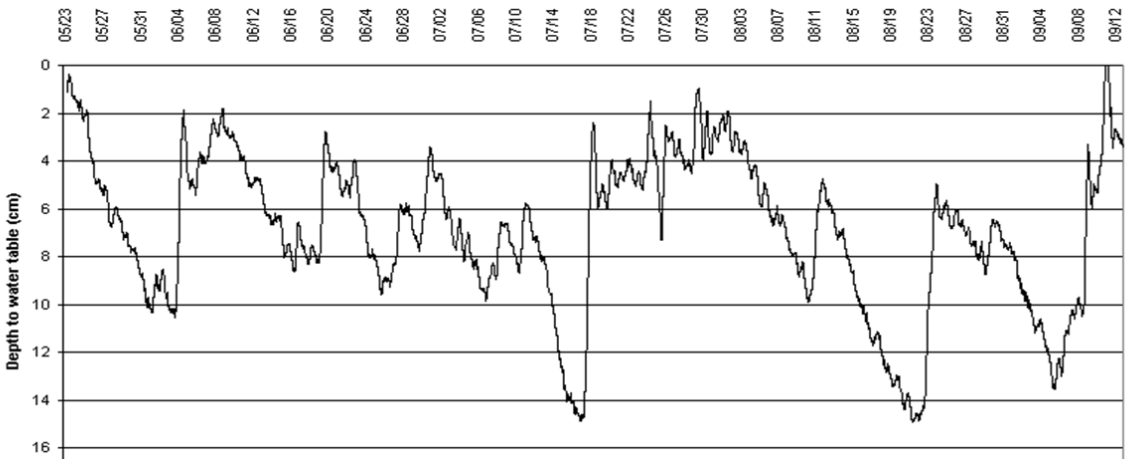
Investigation Report

Students carry out an investigation involving the collection of primary data through measurement or surveys, processing of the data, and presentation of results and conclusions. The objective is to develop ***skills in data collection and analysis***.

At levels 1 and 2, students might carry out a survey of methods of travel to college. A suitable questionnaire would need to be devised, perhaps asking about distance between home and college, travel costs involved, and any changes made to travel arrangements during hours of darkness or bad weather. After analysing the results, students might be able to make recommendations to their college or the transport operator, outlining problems which were identified and improvements which might be made to the transport provision.

At advanced level, an example is a project by our geography students to monitor water levels in an area of peat bog in the Welsh mountains. This was carried out by means of an electronic water depth recorder inserted into the peat.

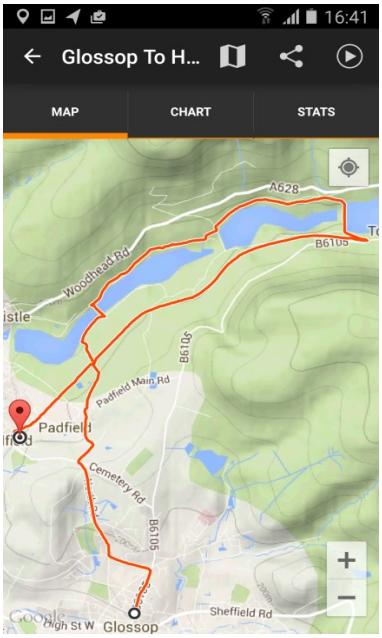
After downloading the data, students were able to plot variations in the water table over a period of several weeks. This allowed them to assess how the peat stores water after heavy rain, and regulates flooding downstream.

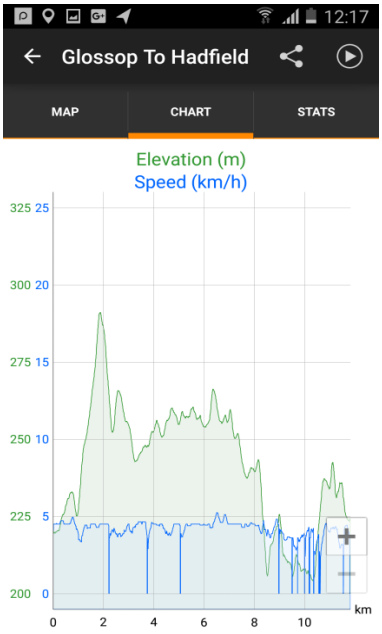


Paper Discussion

Students are presented with a problem which needs to be solved using an unfamiliar mathematical technique. Information about the technique is provided in the form of a worksheet, website or text book article, then students are asked to teach themselves. The objective is to develop ***independent learning skills***.

At levels 1 or 2, students might carry out a project to use a mobile phone application for monitoring physical activity. Walking or cycling routes can be shown on maps using GPS data, including changes in altitude and calories burned.





Students are provided with instructions for use of the software, and teach themselves to operate the system.

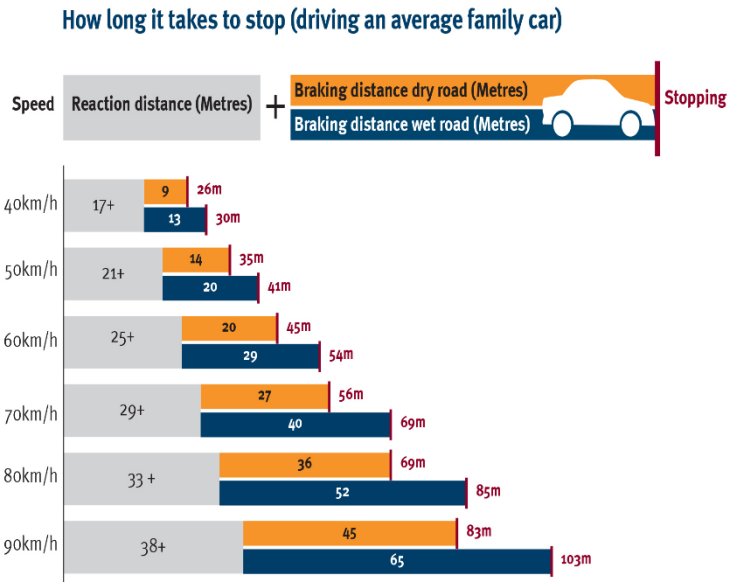
As a more advanced example, biology students might carry out a survey across a system of coastal sand dunes to explore the factors which affect the distribution of plant species. Factors of importance might include: variations in the moisture content of the sand, changes in salinity with distance from the sea, and the speed of the wind.

To make correlations between plant distribution and environmental factors, we provide the students with statistical analysis software. Rather than the teacher giving instruction, the students are asked to explore the software themselves by working through tutorial notes and running example data sets. The students then move on to analyse their own data and draw conclusions.

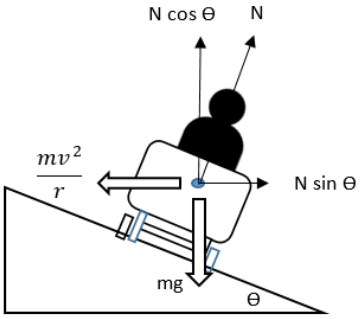
Mini Scientific Research

Students design and develop their own project to investigate a problem of genuine interest within their vocational field. Students have freedom, under the guidance of a tutor, to decide the objectives of the project and the methods to be used for collecting and analysing the data. The objective is to develop ***problem solving and research skills***.

As an aspect of road safety training for young drivers, students at levels 1 or 2 might investigate the emergency stopping distances for cars under different conditions. Data is available on the internet for stopping distances in dry or wet road conditions, and with new or worn tyres. Emergency stopping distances have also been recorded for drivers under the influence of alcohol or drugs, or distracted by the use of a mobile phone.



At a more advanced level, physics students investigated the motion of the small roller coaster in the fun fair on the seafront at Barmouth. They were able to calculate the velocities and acceleration of the cars at different points around the track, and to determine the optimum banking angle as the cars travel around the tight curves of the track.



Conclusions

Less academic pupils often face difficulties in learning mathematics at school. They may see the subject as confusingly abstract, and irrelevant to their future careers or personal interests. This can lead to boredom in lessons, and examination failure then reinforces negative attitudes and loss of motivation.

When students begin vocational courses at college, we have a great opportunity for a fresh start. Numeracy activities can be embedded in a way which demonstrates the crucial importance of mathematics in almost every workplace. The practical approaches developed by Tang, Sui, & Wang can be effectively applied in a wide variety of teaching situations. Student motivation is increased, leading to improved learning in both numeracy and in the student's main vocational subject.

References

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