BOWLAND MATHS

Keeping the Pizza Hot!!!



King's College London in collaboration with the Bowland Trust

Meeting the challenge of home delivery.

A new Pizza shop cooks wonderful pizzas but wonders how far they can stretch their home delivery service. They need to ensure they keep their pizzas hot on the journey from shop to home. This is the challenge.

This case study is based on building a mathematical model to address a problem that would occur in a home-delivery pizza shop. The process of mathematical modelling has at least two distinct contexts: the originating context, here the pizza shop, and the mathematical context.

The case study as four distinct parts. Initially the problem is grounded in the originating context of the pizzeria. The potential market for the shop is limited by the distance that can be reached *and* keeping the pizza warm enough to be edible.

Part I

The opening part of the case study sets the scene. The pizzeria opens, sends out pizzas for home delivery but finds that customers are concerned to have their pizza delivered at a reasonable temperature.

A PowerPoint presentation is included to set up the question, which is the best way to keep a pizza hot?

This can be attacked in two ways: firstly some trial pizzas can be heated and using temperature probes the falling temperatures recorded over time and the readings are collected in a data base.

Alternatively a video is provided showing some pupils from another school doing the experiment and recording the data, which is then provided ready for analysis. Pupils can then print out or plot their cooling data and describe what happens and predict how long it takes for the pizza to cool to an acceptable temperature.

The National Curriculum

Mathematics equips pupils with uniquely powerful ways to describe, analyse and change the world

The new National Curriculum has foregrounded mathematical more than ever before. The bold claim here is carried forward in the Key Concepts and Key Skills at Key Stage 3. The Pizza problem presented in this case study precisely addresses this aspect of the National Curriculum whilst challenging pupils to engage in a good level of mathematics.

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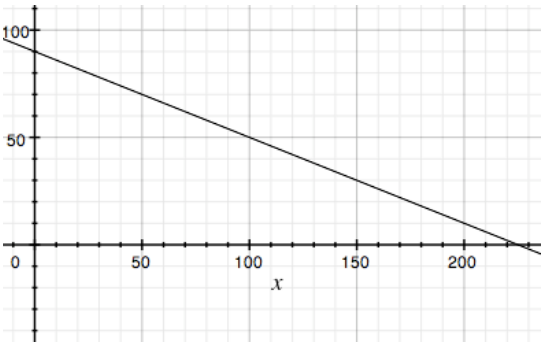
Mathematical modelling

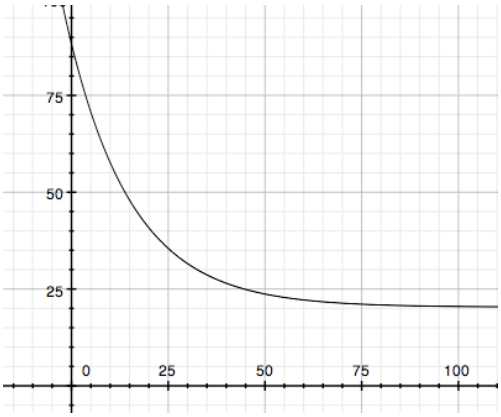
The move from 'reality' of the pizzeria to a mathematical model of cooling curves takes place in parts 2 and 3 of the case study. In part 4 the move is back to the pizza shop to determine how to deliver the best pizza in town

part 2



This part is where the model starts to be given more detail. The raw data collected from the cooling trials is examined and a linear graph is examined for goodness of fit. There is a small applet designed to support pupils with fitting lines called *Equator* which is included with the pack. It allows pupils to enter the cooling data and then drag a graph line to lay over the plotted points. A straight line appears to give quite a good fit for the first few data items. However, extrapolation predicts that the pizza will self freeze over time, which all pupils recognise as something which does not happen. Consequently the straight line is rejected and alternative functions sought.

part 3



Part 3 of the project starts to look at more sophisticated models. Having recognised that a curve is needed pupils can try out functions with various different graph images. A quadratic section gives quite a good fit to empirical data, but eventually predicts the temperature will rise. The inverse function can't be bent into an appropriate shape. The exponential serves well as a description. There is a good opportunity for pupils to use not only *Equator* but also a more complicated graphing package to fine-tune the functions to give a better fit to the cooling data. Here pupils can note the different attributes of these different functions.

part 4

For part 4 we now return to the originating context, the Pizzeria. A report of the findings about the packaging and the cooling times are made to the Pizza shop owner, but the decision about which is the *best* wrapper resides with the Pizza shop and *not* with the mathematical modellers. At this stage pupils will need to consider the simplifying assumptions made in building the model, and might extend the problem by looking at the area that can be covered by the delivery mopediers. This area can be based around your school, making it very close to pupils who will therefore have lots of local knowledge to draw on.

To close the pupils make presentations of their projects.