**Core Maths - preparation for the future and enhancing the post 16 provision map**

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Abstract

Core Maths qualifications are a suite of new Level 3 qualifications for students in post-16 education. Core Maths courses are aimed at students who have passed GCSE mathematics at grade C or above but who are not taking A or AS level mathematics. The qualifications will help students retain, deepen and extend their mathematical skills and understanding through the use of meaningful and relevant problems, preparing young people for university, employment and life.

This paper showcases three examples which, taken together, exemplify the nature of Core Maths, the way it is taught, and how students develop their knowledge, understanding, and skills while studying for one of these qualifications.

1. Introduction

Core Maths qualifications are a suite of new Level 3 qualifications for students in post-16 education. Core Maths courses are aimed at students who have passed GCSE mathematics at grade C or above but who are not taking A or AS level mathematics. The qualifications will help students retain, deepen and extend their mathematical skills and understanding through the use of meaningful and relevant problems, preparing young people for university, employment and life.

Core Maths is ideal for a wide range of students progressing to education courses with distinct mathematical or statistical elements such as psychology, geography, business and management, sociology, health sciences, biology, education and IT.

The government’s aim is that by 2020 the vast majority of students will continue to study some form of mathematics as part of their post 16 education. Therefore, as the number of students taking Core Maths is expected to grow steadily over the next few years, this information is to help universities become aware of the skills and knowledge that students with this qualification will bring to their higher education.

2. Why is Core Maths important for higher education?

A number of recent reports have demonstrated how students in the UK lag behind their peers in other countries when it comes to participation in mathematics after the age of 16, and that as a consequence many are not well-prepared for the demands of their university courses. For example the Nuffield report (Hodgen et al, 2010) showed that, in a survey of 24 countries, England, Wales and Northern Ireland had the lowest levels of participation in mathematics to age 18, with fewer than 20 per cent of 16-19 year olds in England studying the subject. Following this Higher Education Academy (HEA) report (Hodgen et al, 2014) studied the mathematical needs of students in seven disciplines: Business and Management, Chemistry, Computing, Economics, Geography, Sociology and Psychology. The report found that all the disciplines in the study require mathematics and/or statistics to some extent. It found that many students arrive at university with unrealistic expectations of the mathematical and statistical demands of their subjects and that lack of confidence and anxiety about mathematics/statistics are problems for many students.

The number of students taking A and AS level in mathematics has grown healthily in recent years and for many students A/AS will be the qualification of choice. However, at present many students encounter no mathematics after GCSE and their understanding, fluency and confidence are inevitably weakened. A large number of students are missing out on the mathematics that would help them with their studies in higher education. Core Maths is designed to help these students.

3. What is Core Maths?

Core Maths is a Level 3 qualification, normally taken over two years alongside A levels or other Level 3 qualifications such as BTEC. It is designed to help students retain, deepen and extend mathematical knowledge and skills gained at GCSE. It focuses on using and applying mathematics to address authentic problems drawn from study, work and life. The Core Maths courses include new level 3 content such as statistics, financial mathematics and using algebra. Core Maths qualifications attract the same UCAS points tariff as AS Mathematics.

There are six qualifications offered by the five Awarding Organisations. These are all ‘badged’ as Core Maths qualifications. Details, including sample examination papers, can be found through the Core Maths Support Programme website (CMSP, 2017a).

All Core Maths qualifications:

* deepen competence in the selection and use of mathematical methods and techniques;
* develop confidence in representing and analysing authentic situations mathematically and in applying mathematics to address related questions and issues;
* build skills in mathematical thinking, reasoning and communication;
* consolidate and build on students’ mathematical understanding and develop further mathematical understanding and skills in the application of mathematics to authentic problems;
* foster the ability to think mathematically and to apply mathematical techniques to variety of unfamiliar situations, questions and issues with confidence;
* provide a sound basis for the mathematical demands and varied contexts that students will face at university.

By following a Core Maths course students will be expected to:

* use a variety of mathematical and statistical approaches to represent and analyse relatively well-defined situations, including complex and unfamiliar situations;
* address authentic issues and questions by applying mathematical approaches with purpose to generate solutions, insights or answers;
* evaluate the relevance of solutions in the context of the situation, establish how they could be used and communicate findings accurately and meaningfully;
* generate and apply mathematical solutions to non-routine questions and problems;
* interpret new situations in terms of mathematical and quantitative characteristics;
* make judgements about strategies and methods to achieve a solution;
* take creative approaches where appropriate; and test and evaluate answers and conclusions;
* explain mathematical reasoning and conclusions to others and justify specific approaches taken to the problem;
* interpret conclusions on the basis of mathematical understanding and explain limitations to answers and conclusions.

4. How Is Core Maths Taught?

Core Maths builds on GCSE maths with a sharper focus on problem solving skills by considering and tackling mathematics in meaningful contexts. This includes financial applications of mathematics as well as further statistical ideas that can support work in other subjects they will be studying such as psychology, health sciences, geography, sociology and even history. Although the course is mainly led by mathematics teachers, the involvement of other subject specialists is welcomed to ensure students appreciate the applications of mathematics in different subjects.

5. Illustrative Examples

In the section we give a summary of three example resources/lessons/areas of study which, together, exemplify the rich and diverse nature of Core Maths and its emphasis on contextualised problem solving in meaningful contexts. Further activities, topics, areas of study, problems, resources, and exemplars lessons have been published by the Core Maths Support Programme (CMSP, 2017b). These, taken together, provide an overview of the nature of Core Maths, the way it is taught, and how students develop their knowledge, understanding, and skills while studying for one of these qualifications. The qualifications cover a range of mathematics and statistics relevant to the target audience, including, for example: analysis of data; finance; estimation; critical analysis of given data and models (including spreadsheets and tabular data); the normal distribution; probabilities; correlation and regression; critical path analysis; graphical methods; rates of change; exponential functions; modelling, most of which are supported through a number of interesting and diverse resources in (CMSP, 2017a).

5.1. How much do I need to earn?

This activity addresses the problem:

* You are 25, single and looking for a sales and marketing job in Leeds.
* What advertised salary should you be targeting?

This task calculates the net income from the gross income and uses a spreadsheet. Students will need problem solving and estimation skills to get started; they will then need to use summary measures and a “wisdom of the crowd” approach. The modelling aspects of the main task will require assumptions to be made and a degree of research on the web. This task is designed for group work, and should take about two one hour sessions.

Polya’s four step problem-solving process is recommended:

* Understand and Plan;
* Key Assumptions;
* Collect and Analyse the Data;
* Conclusion, Review, Interpret and Reflect.

Different groups will come up with different assumptions and expenses categories but this is only a problem if all results are pooled.

The next steps are to design a spreadsheet to calculate the net salaries. The students should perform the calculations by hand held calculators until they are confident to put onto Excel. There is an example on tab 2 of the spreadsheet in Cartmell and Prestwich (2017).

The completion of “Review, Interpret & Reflect” is effectively done via a group presentation including the validity of the assumptions made. Each group should propose different questions on the final solution.

The resources required for this are up to date Income Tax and National Insurance bands.

5.2. Fake news?

There are consistent aims threaded throughout all mathematics ‘programmes of study’ and Core Maths is no exception. These are:

* Fluency;
* Reasoning;
* Problem solving.

Teaching through problem solving is key to Core Maths and finding good problems is at the heart of planning a Core Maths lesson:

*“A problem occurs when students are confronted with a task, which is usually given by the teacher, and there is no prescribed way of solving the problem. It is generally not a problem if students can immediately solve it”* (Nohda, 2000).

Articles in the news can be a rich resource for Core Maths problem solving ideas. The Quibans (Question inspired by a news story) website (Quibans, 2017) is an excellent source for finding and structuring these stories. The idea of ‘fake news’ and how quickly they can be spread via social media, is an example of a current news story which may appeal to students.

**Fox News And Trump Are Conspiring To Spread Fake News To Discredit Protesters**

*By Jason Easley* *on Mon, Feb 6th, 2017 at 5:37 pm*

And the idea that we – and schools - need to do something about it, is itself in the news.

**Schools should teach pupils how to spot 'fake news'**

*By Sean Coughlan Education correspondent 18 March 2017*

Core Maths lessons may be ideally suited to tackle such modern day dilemmas.

‘Scams’ have of course existed for eternity, and although not the same as ‘fake news’, do share some similarities with the more modern day ‘sleight of hand’; both are intended to fool, charm or seduce the recipient. The ‘Scams’ problem-solving activity (CMSP, 2017c) featured on the CMSP website showcases a number of real-world examples of frauds and scams that students are asked to analyse and evaluate (CMSP, 2017d). (This is a resource developed by MEI (MEI, 2017a), with funding from the Department for Education as part of the Critical Maths project to develop a post-16 mathematical thinking curriculum based on ideas from Professor Sir Timothy Gowers (MEI, 2017b).) Students can use various tools (e.g. simulation or a more theoretical probabilistic analysis) to work out why the proposed schemes are fraudulent.

This task is accessible to all Core Maths students, being of ‘low threshold, high ceiling’ (LTHC). Students will simply need a prior knowledge of theoretical and experimental probability; both of these topics will be familiar from GCSE mathematics.

The ‘Scams’ activity presents a set of three scenarios (available on a **Student sheet** (CMSP, 2017e)):

* Genuine Psychic;
* Football Predictions;
* Pyramid Schemes.

The **Teacher notes** (CMSP, 2017f) provides guidance about the presentation of these questions to students and suggestions for simple approaches to analysing the ‘scams’ presented. Students could use spreadsheets to model each of the schemes. In the first two scenarios, the random number function could be used to generate sets of data to model the real-world behaviour of the proposed schemes. Students could go on to investigate a wider range of frauds and scams. Some examples are provided on the websites linked to the resources.

5.3. Microlives

Core Maths introduces students to new content at level 3, and develops skills in applying this content. Much of Core Maths, however, is about developing skills in applying what students have learned at GCSE within level 3 contexts and it is this that provides the main challenge for Core Maths students (and their teachers). This means, above all, learning how to problem-solve and develop skills and dispositions which make students ready for work (CBI, 2016) as well as academic study. These include:

* self-management;
* working creatively and collaboratively;
* analysis;
* confidence to plan and make decisions in the face of uncertainty.

The learning resources created by the Core Maths Support Programme (CMSP, 2017b) embody this problem-solving approach, which is very well illustrated by the microlives activity (CMSP, 2017g).

A microlife is a unit of risk representing a half an hour change in life expectancy. Introduced by David Spiegelhalter and Alejandro Leiva based at Cambridge University (Spiegelhalter, 2011), microlives are intended as a simple way of communicating the impact of a lifestyle or environmental risk factor, based on the associated daily proportional effect on expected length of life.

In the Core Maths activity, students are presented with a scenario where they are responsible for spending a £1,000,000 public health budget. They are provided with data on the harms and benefits of a range of human activities, and must select a suite of costed interventions to achieve optimum health benefits for their city.

This problem-based approach within a real world project shifts control of the process from teacher to student. In so doing, students are well positioned to lead their own learning, and so develop those skills increasingly demanded by employers and university departments.

6. Summary

By taking Core Maths students will have continued using and applying GCSE material in mathematics and statistics, as well studying and applying some level 3 material, all in context, for the two years prior to entry to university. At present many of these students experience a two-year ‘maths gap’ which results in a lack of fluency and confidence in applying mathematical skills, even when applying known techniques and methods to new problem areas. This has a knock-on effect for provision of student support in universities and graduate-employability. Core Maths will fill this gap.

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