Engaging able mathematics students: King Edward VI Camp Hill School for Boys

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Brief description

This school is highly successful in engaging and developing young more able (gifted and talented) mathematicians both within mathematics lessons and in extra-curricular activities.

Overview – the school's message

'In 2010, two of the six members of the British team at the International Mathematical Olympiad were students from this school. Out of a sixth form of 243 students, 196 are studying AS- or A-level mathematics. We believe that our approach is relevant to all schools. Our message is to focus on the encouragement of interest and development of understanding in the subject. We believe that early and repeated taking of GCSE exams can work against this. By focusing on problem-solving through varied and engaging teaching and learning methodology, we are able to better prepare all our students for a future where mathematics is highly important. While the achievement of all of our students is outstanding, the most able students are able to flourish at the very highest levels.'

Mike Roden, Headteacher

The good practice in detail

How can mathematics best be taught to grab the interest and enthusiasm of young people? Can high-quality results be achieved without turning our classrooms into exam factories? The experience of King Edward VI Camp Hill School for Boys shows that a focus on deep understanding and rich activities is the key to success.

Problem-solving

Problem-solving is a major part of lessons. Problems are used to create interest in topics and as lesson starters, sometimes related to the topic being covered, but by no means always. But where can one find examples suitable for the most able students?

The teachers use five main sources:

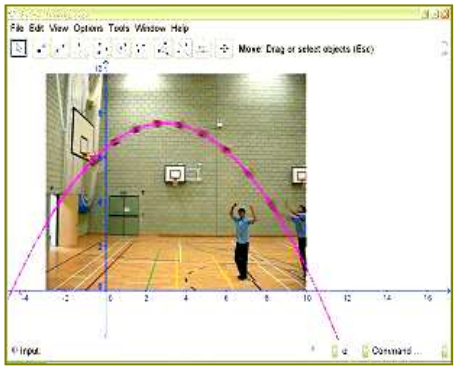
- The United Kingdom Mathematics Trust (UKMT). The UKMT is well known for running mathematics competitions. These problems provide a rich source of material for the classroom. UKMT provides a computer disc of these problems categorised into the appropriate level and area of mathematics in a searchable database. This makes finding a suitable problem to link to the current topic a much easier task. There are also good questions and solutions online of Mathematical Olympiad type problems. These can be used with a range of more able students, and by no means limited to those who would qualify for the Olympiad. The questions when downloaded can look very dense, so teachers usually cut and paste a small selection or use just one problem.
- The Mathematical Association publishes several books of problems.
- The nrich website contains a large number of searchable problems. Many of these are designed to be accessible to a wider range of students than just the most able, but with opportunities for extension.
- The National Council of Teachers of Mathematics (of the USA) publishes 'Mathematics Teacher' which contains good daily problems.
- The (British) National Centre for Excellence in Teaching Mathematics (NCETM) also contains a range of ideas.

In solving problems, teachers aim to foster the attitude that students, even the most able, should expect to struggle and, indeed, welcome the challenge. As Paul Bruten, the Head of Mathematics, explains: 'Students wouldn't give up on a computer game just because they failed to solve it first time. This persistence is needed with mathematics problems as well.' Students often solve problems in pairs or small groups, and after a solution has been discussed, they sometimes make informal posters displaying their solutions. Paul explains further: 'Employers love this approach because students learn to solve problems, becoming more proficient at working in small teams and at communicating their ideas. Collaboration and communication are vital to solving problems in mathematics.'

Making posters to display solutions

Practical work and ICT

Schemes of work make frequent reference to using and applying mathematics and to applications of ICT. These provide stimulating and interesting contexts which make mathematics fun and relevant and grab the imagination of able students. You can find a short extract from the Year 9 scheme of work here. An example of practical work is when Year 10 students throw a basketball in the sports hall, photograph the path and use software to fit a parabola over the path that is traced out.



Using GeoGebra to trace the path of the basketball

The teachers are also enthusiastic about using ICT. They find graphical calculators particularly useful, not only for curve sketching. As Paul Bruten explains: 'Graphical calculators are easily distributed. They switch on in seconds. They don't take up too much room or require a separate computer suite and can be moved in and out of the field of view. The display is a bit chunky, and very soon many students will have free "apps" on their mobile phones and other devices which will perform many of the graphing tasks.' Small-scale hand-held technology enables mathematics teachers to make, for example, learning about the quadratic graph a much more investigational and exploratory process.

Finding the time needed to gain technical competence with software is a common barrier to using ICT, even in schools where every teacher has an interactive whiteboard. Teachers at Camp Hill Boys, therefore, prefer software that is mathematically intuitive. The school has a licence that enables them to give Autograph to students. The school also encourages students to use GeoGebra, which is free, easy to use and suitable for dynamic geometry and algebra. When students become proficient with such software, they make their own explorations of mathematics and are also able to support each other. Such high-quality software can itself be an important stimulus for able students.

Using graphic calculators

Students produce their own video clips to illustrate mathematics topics. In lessons, short video clips are used from websites such as YouTube or the BBC. One such example is of a diver which provided a context for mathematical modelling.

Questioning and dialogue in lessons

All students, including the most able, need rich opportunities to talk about their mathematics. This allows the teacher to know how well they understand a particular topic, and helps the students themselves to learn more effectively. As teacher Peter Jack explains: 'I don't think of an unexpected answer to a question I have asked as being necessarily wrong. It might be the right answer to the question as the student saw it. It gives me insight and understanding into what his mind is thinking. We therefore have a culture of valuing incorrect answers.'

Once this confidence is established, a productive dialogue between teacher and students and between the students themselves, can take place, with the teacher demanding ever more precise answers. Paul Bruten adds: 'Let the debate run, and don't feel too embarrassed if, on occasion, you as a teacher feel a bit out of your depth. Keep turning it back to the students to do the thinking, and to think about their thinking. Fermat's last theorem took centuries to solve! And you would never just reach an instant decision in design technology, so why should we ever accept a quick answer in mathematics? Mathematics also needs time to savour and enjoy!'

Participating in practical mechanics

Routine practice

All students, including the most able, need, at times, to practise a technique, such as multiplying out brackets in algebra. Teachers at this school find that the exercises in many

textbooks are somewhat long and uninviting. They adopt the strategy of explaining to the students that the techniques are important for their 'tool-box' of algebraic techniques. They ask the students to look through the questions and explain how they see the questions developing the topic. They then discuss with the students which questions look valuable and agree which to do to obtain the routine practice needed. In this way students are encouraged to think about their mathematics even when simply practising routine techniques.

Entry policy for GCSE

No student is entered for GCSE before the end of Year 11, although many will take a Free Standing Mathematics Qualification in additional mathematics alongside their GCSE. This allows the maximum time to establish a real understanding and enjoyment of mathematics, rather than mathematics being seen as a long sequence of tests and module examinations. Also, this approach results in a very high proportion of A* grades at GCSE, over three-quarters of sixth form students taking A-level mathematics and large numbers taking the subject at university.

Extra-curricular provision

Outside lesson time, a range of enrichment for more able mathematics students includes the United Kingdom Mathematics Trust (UKMT) competitions, a lunchtime club for students in Years 7 to 9 which focuses on solving Junior Mathematical Olympiad problems, and a programme of Saturday morning Master Classes. The library contains a diverse selection of books related to mathematics, including topics on the history of mathematics, biographies of mathematicians and books of puzzles. Through the 'Aim Higher' initiative, students can join weekly after-school problem-solving classes which lead to Cambridge University mathematics STEP (sixth term examination paper). There are interesting school trips, including to Bletchley Park to experience the cracking of the German Enigma code in World War II.

The school's background

King Edward VI Camp Hill School for Boys is situated in the Kings Heath area of Birmingham on a site shared with a girls' grammar school of the same foundation. A high performing school, it was judged outstanding in its Ofsted inspections in 2000, 2006 and 2009. Provision for mathematics was graded outstanding in an Ofsted mathematics survey visit in 2011. The school also offers a wide range of sport and extra-curricular activities.

Are you thinking of putting these ideas into practice; or already doing something similar that could help other providers; or just interested? We'd welcome your views and ideas. Get in touch here.

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