Key Stage 4 mathematics:

what works in eleven schools

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Key Stage 4 mathematics: what works in eleven schools

Audience This document is aimed at practitioners within schools in Wales.

Overview This document looks at what works in eleven secondary schools in which performance in GCSE mathematics is as good or higher than performance in English/Welsh First Language given the percentage of learners entitled to free school meals within the schools' catchment areas.

Action required Practitioners are requested to review the information within the document and consider how it might influence practice within their school.

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Additional copies This document can be accessed form the Welsh Government's website at www.learning.wales.gov.uk

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Contents

Introduction

What is this report aiming to do?

One of the findings of the data analysis carried out by the School Standards Unit (SSU) during the first year of its existence was the significant underperformance across Wales in mathematics at GCSE. The percentage of learners gaining grades A*–C in mathematics is consistently lower than those gaining the same grades in English/Welsh First Language across all four consortia and in all 22 local authorities.

This report written by the SSU looks at what works in eleven secondary schools that buck this trend and in which performance in GCSE Mathematics is as good or higher than performance in English/Welsh First Language given the percentage of learners entitled to free school meals within the schools' catchment areas.

If the strategies and practices outlined in this report work for those schools they could work equally well for you. There is always a danger that anyone reading a report like this one will say that there's nothing new in it and that his/her school is already doing these things. In that case the reader should ask him/herself if the actions are having the same impact as in these eleven schools and if not, why not. **Schools and consortia should take note of the contents of this report when planning for improvement in mathematics**.

At this point it is important to emphasise that throughout the report where reference is made to staff undertaking extra revision or consultation sessions the schools have planned for this and it is not an addition to staff duties and contact hours.

What is the School Standards Unit?

The School Standards Unit was established in May 2011 as a catalyst to generate ambition to improve outcomes. The Unit has responsibility for sharpening the use of data, strengthening accountability, ensuring consistent sharing of high-impact practice and evaluating policy implementation. In this role it works closely with Estyn. The stocktakes it undertakes termly with the four regional consortia are used as a vehicle of challenge and support for consortia to work systematically to raise standards of attainment in their schools. The Unit uses secondary school banding as a means for consortia to challenge and provide support for underperforming schools to improve learner attainment.

Why are we doing this?

In autumn of 2010 it was becoming increasingly clear that Wales was not performing as well as the other home nations in end of Key Stage 4 examinations. Added to this was Wales' poor performance in the 2009 PISA assessments.

What does the data tell us?

This report refers to data up to 2011 as the final data at school and local authority level for 2012 was not available at the time of production.

In 2011, 60.8 per cent of learners entered for mathematics achieved Level 2 compared with 67.6 per cent in English and 74.6 per cent in Welsh First Language. A similar picture was the case for 2010, 59.9 per cent of learners entered gained the Level 2 in mathematics compared to 67.6 per cent in English and 73.4 per cent in Welsh First Language.

In 2011, only 41 out of the 221 secondary schools in Wales achieved performance in mathematics at GCSE higher or at the same level as that for English/Welsh First Language.

Wales performed below the Organisation for Economic Co-operation and Development (OECD) average in the PISA results for mathematics in 2009, a score below that for reading and well below that for science.

Figures 1–4 show the difference between the 2011 English/Welsh First Language scores and those for mathematics for each authority in the four regional consortia and for the consortium as a whole.

Figure 1: North Wales Consortium

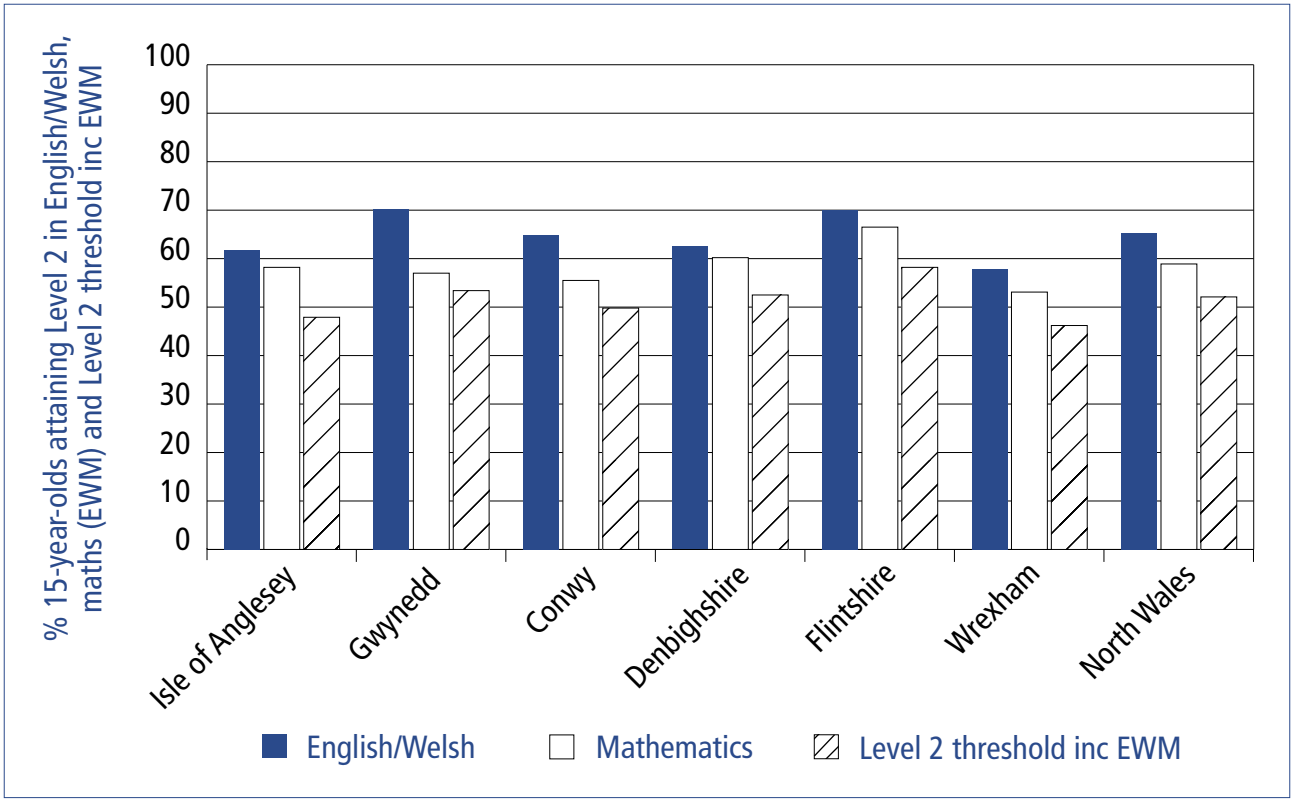


Figure 2: South West and Mid–Wales Consortium

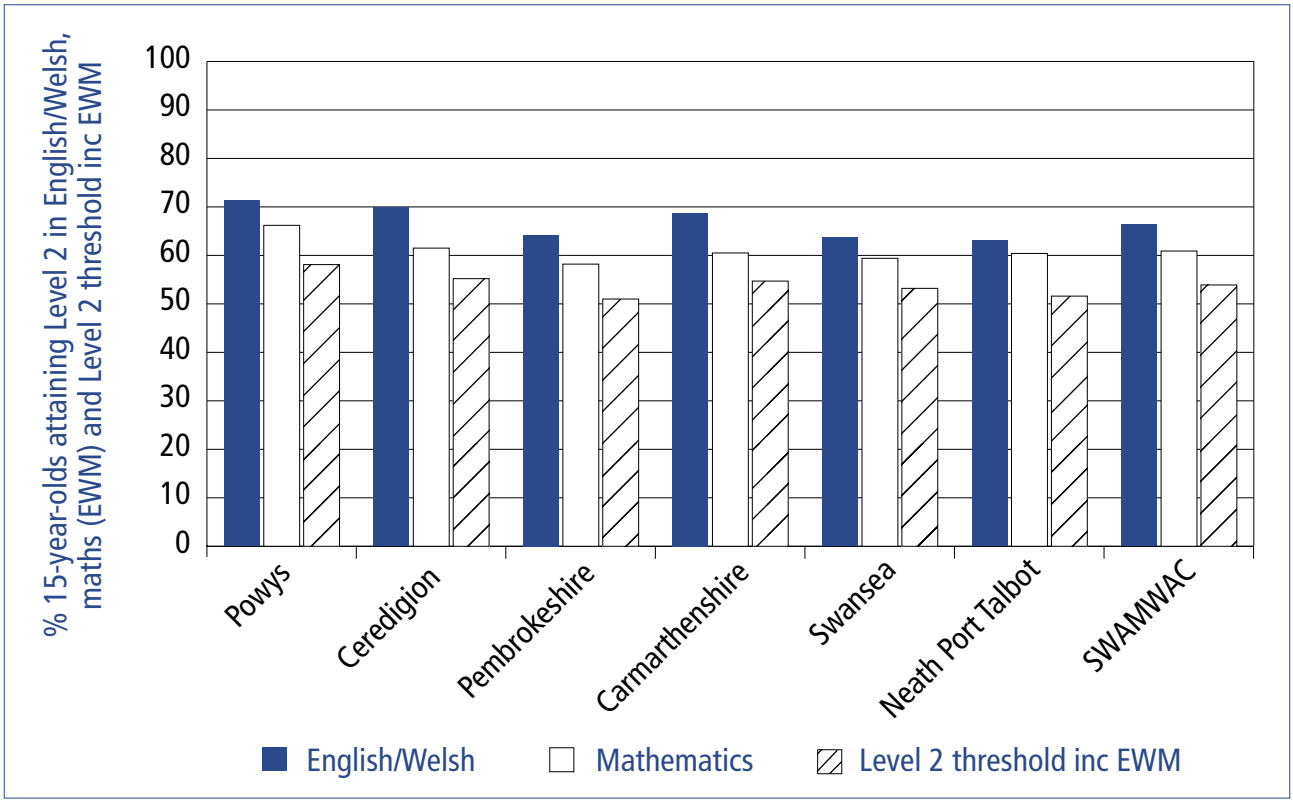


Figure 3: Central South Consortium

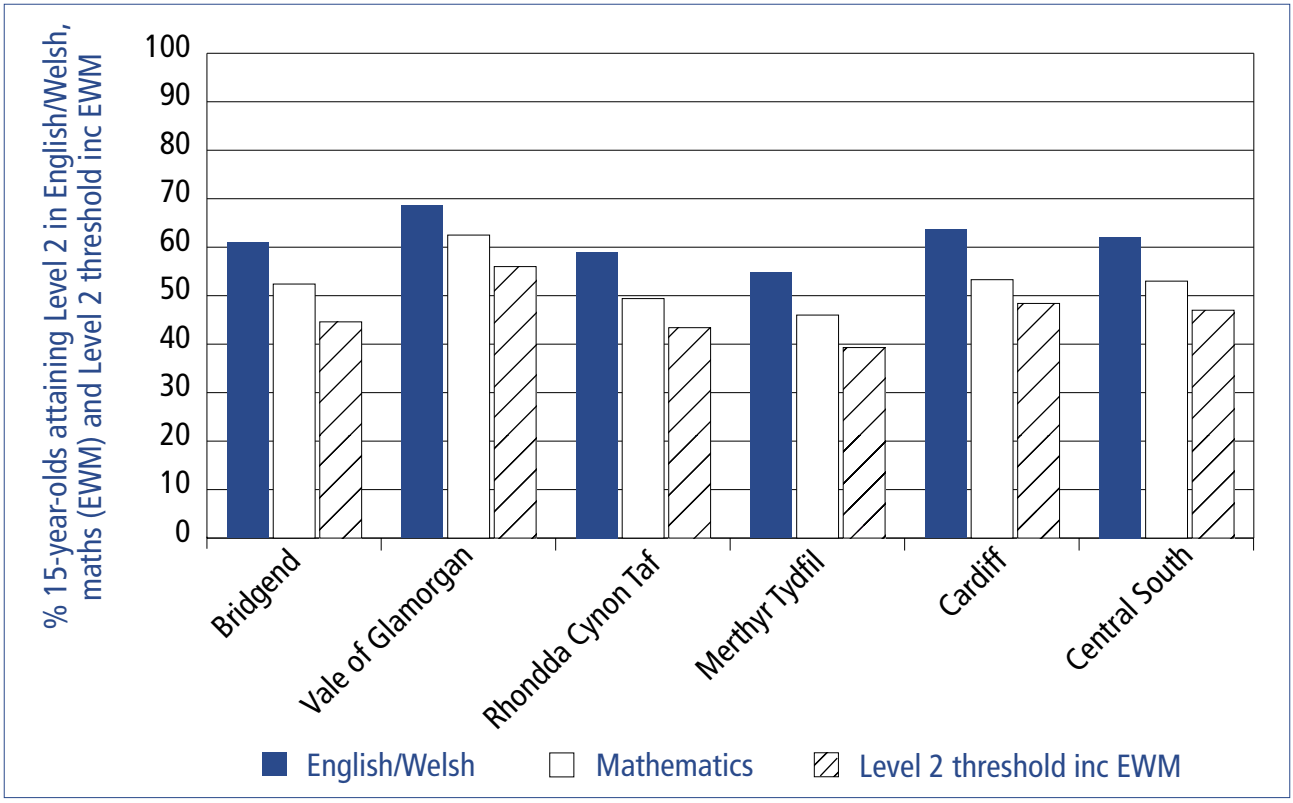
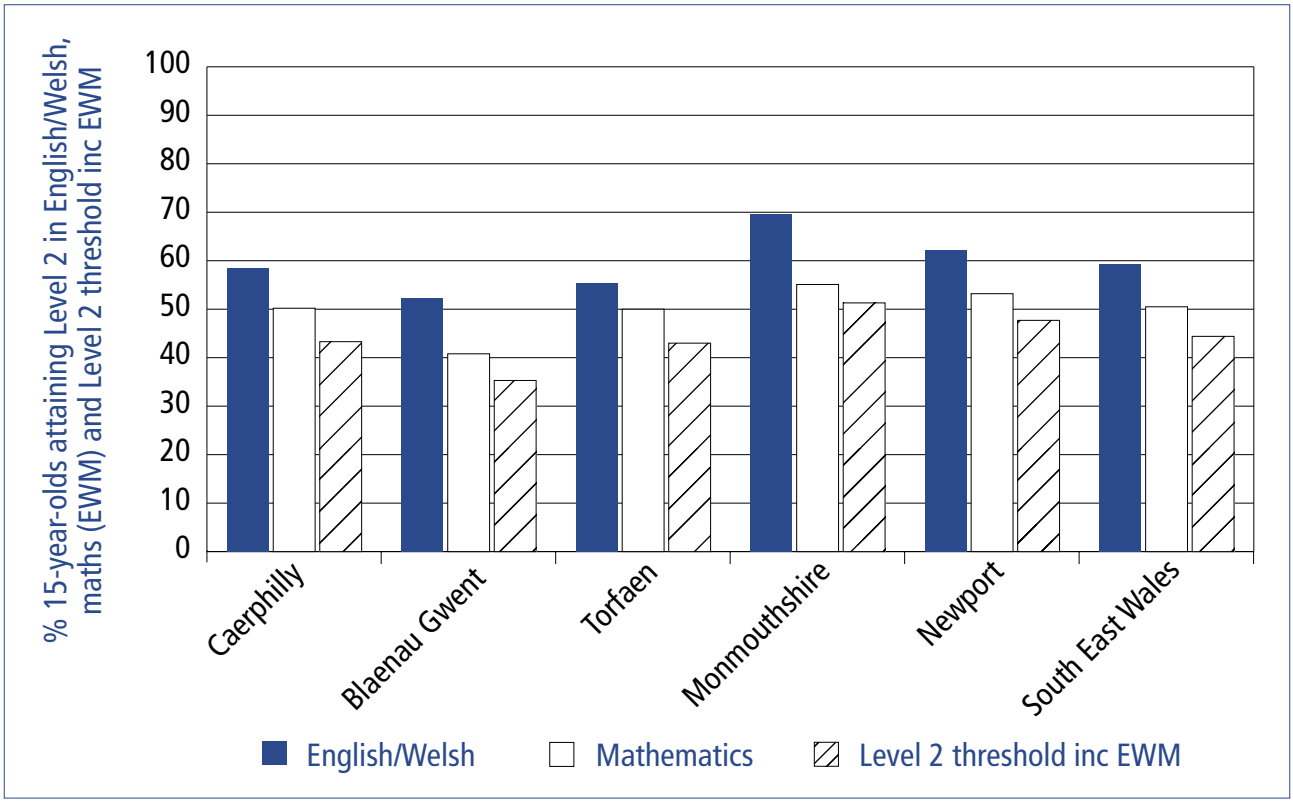


Figure 4: South East Wales Consortium



Following the initial stocktakes with the SSU each consortium agreed either to continue with investigations already set in place to examine the causes of this problem or to instigate such an investigation. Each consortium agreed to set in place support with their schools to improve performance in mathematics. This involved developing and monitoring learner tracking instruments, wider training initiatives and individual actions plans for underperforming schools but especially those schools in Bands 4 and 5. The SSU receives termly updates on these courses of action and has set with consortia a trajectory for improvement for the Level 2 inclusive of English/Welsh First Language and mathematics up to 2014. If this performance indicator is to improve in Wales then the key will be improvement in mathematics at GCSE.

The sample of schools

Eleven schools were selected based on their performance over the last two years for mathematics in relation to their expected performance given the percentage of learners entitled to free school meals. Figure 5 shows, in the column entitled residual, how much better each school scored in 2010 and 2011 than would be expected given the percentage of learners entitled to free school meals. Nine out of the eleven schools performed better in 2011 in mathematics than in English/Welsh given the percentage of learners entitled to free school meals by comparison with a national rate of 120 out of 221 schools.

The schools selected for visits were the following:

- Bishop Gore School – Swansea
- Bishopston Comprehensive School – Swansea
- Cardiff High School – Cardiff
- Cefn Hengoed Community School – Swansea
- Cynffig Comprehensive School – Bridgend
- Dyffryn School – Neath Port Talbot
- John Summers High School – Flintshire
- Llangatwg Community School – Neath Port Talbot
- Michaelston Community College – Cardiff
- Newbridge School – Caerphilly
- Ysgol Gyfun Gŵyr – Swansea.

With one exception all the schools are in either Bands 1 or 2. Many of the schools have had top rate Estyn inspection outcomes (see estyn.gov.uk).

Figure 5: Summary of performance at Key Stage 4 of the sample of schools

Local authority	School	Band 2011	FSM % 2011	Mathematics residual		Average mathematics residual	Mathematics – English/Welsh difference residual
				2010	2011		2011
Swansea	Bishopston Comprehensive School	1	3.5	7.4	8.0	7.7	5.9
Swansea	Ysgol Gyfun Gŵyr	1	9.5	5.8	5.1	5.5	1.8
Cardiff	Cardiff High School	2	5.6	5.2	5.4	5.3	2.3
Bridgend	Cynffig Comprehensive School	2	31.5	6.1	4.4	5.3	–3.3
Swansea	Cefn Hengoed Community School	1	36.2	4.9	5.2	5.0	2.6
Swansea	Bishop Gore School	1	25.2	3.7	6.1	4.9	1.6
Cardiff	Michaelston Community College	4	48.4	4.9	4.6	4.7	–1.9
Flintshire	John Summers High School	2	36.6	2.1	7.1	4.6	4.6
Neath Port Talbot	Dyffryn School	1	19.1	3.7	5.4	4.6	0.8
Caerphilly	Newbridge School	1	15.2	3.4	5.2	4.3	3.5
Neath Port Talbot	Llangatwg Community School	2	20.8	4.2	4.2	4.2	3.4

Semi-structured interviews were held with the headteacher, the head of mathematics and other members of the school leadership team and the mathematics department. A draft set of questions was prepared in advance and shared with the schools prior to the visits.

Main findings

The reason for high performance in all the schools can be identified because:

- the school leadership team and the middle management team have high expectations of all departments but especially core subject departments. In some cases the performance of the mathematics department was turned around as the result of a concerted effort by the head and the senior leadership team
- the department has a highly effective scheme of work which it is constantly revising to fit the needs of learners as they progress through the school. A number of text books and resources are used. Not one of the successful schools depended on a single text book
- the department enthuses learners and treats them as young mathematicians. In this way the fear of mathematics as a difficult subject is removed. Teachers act as role models; learners are expected to be problem solvers and support fellow learners. Learners and teachers enjoy mathematics
- lessons are consistently well thought out and structured. Learners work in a variety of ways, questioning is used carefully and differentiated to involve all learners. Learners assess each other's work and are encouraged to ask for support and articulate their learning problems
- assessment is of a consistently high quality, learners are tracked and have learning targets linked directly to assessment; they understand what skills and tasks they need to acquire next to improve their performance
- setting is used judiciously, when there are underperforming cohorts extra sets are created or teaching assistants deployed to support groups of learners
- homework and revision sessions are targeted to carry forward the work undertaken in lessons
- ICT is used to enhance lessons and assessments but is always linked to mathematical skills
- 'quick wins' are exploited to build confidence but the schools do not resort to gimmicks
- early entry for GCSE is carefully targeted, if used at all. Learners practise examination techniques so as to gain confidence.

How this report works

The main purpose of this report is to disseminate good practice. The SSU is aware that other schools besides the eleven selected here have good practice in mathematics and there will be further school visits to tap in to this practice and to add it to the Learning Wales website. The intention is that this document will be updated from time to time and become a living means for disseminating good practice. Case studies and video extracts will be added throughout the year. There is the potential to add hyperlinks to further data analysis and to the final results for 2012 when they are issued. Each time there are additions they will be announced in the Dysg newsletter.

Key words have been emphasised in bold to assist the reader to locate information with greater ease.

At the end of 'Teaching and assessment' (page 22) there are hyperlinks to case studies for each of the schools. These provide more detail of the work being undertaken by the schools and are worthwhile reading at this point. There is also a hyperlink to the Estyn website so you can search for the school's latest inspection report.

As well as the case studies there are hyperlinks to video extracts made at each of the eleven schools.

At the end of the report references are provided to recent Estyn thematic reports and Welsh Government documents which are related to the topic of mathematics and numeracy at Key Stages 3 and 4.

Distributed leadership

"Strong senior and middle leaders with a firm understanding of what excellence in learning and teaching looks like create the ethos for high standards."

"A 'can do' ethos towards mathematics and numeracy is essential to give learners confidence."

Strategic planning

Strong leadership by senior leaders is a crucial factor in bringing about improved outcomes for learners. A clear definition and understanding of what **excellence in learning and teaching** looks like is central. All of these schools have a strong **ethos for improvement** and effective whole-school self-evaluation procedures. This is usually led by a member of the senior leadership team but implemented rigorously by the head of the mathematics department. In most schools, improvements in mathematics are part of wider improvements across the school.

A 'can do' approach to mathematics is essential for successful learning and high standards of attainment. All schools felt that mathematics is generally seen as a difficult subject and that it is socially acceptable to admit that 'I can't do mathematics and number'.

To counteract this they encourage learners to see themselves as mathematicians and have strong practices in developing numeracy across the curriculum. In Dyffryn, Llangatwg, Michaelston, Cynffig and John Summers schools, mathematics is seen as a journey of challenge and discovery. At Newbridge and Cefn Hengoed schools learners are aware of the success of the mathematics department. At Bishop Gore school learners know they will be taught well. In Cardiff High, Bishopston, Newbridge and Ysgol Gyfun Gŵyr schools, an established work ethos is apparent. In all schools teaching staff in the mathematics department are seen as enjoying mathematics, a spirit that rubs off on learners.

Shared expectations and accountability

Senior leaders at John Summers, Cynffig and Llangatwg schools consider the main reason for their success is the rigour with which **whole-school self-evaluation** is carried out. Self-evaluation procedures are underpinned by first-hand lesson observation and feedback, reviews of learners' work and departmental reviews. In all schools lesson observation and the dissemination of good practice is seen as a staff entitlement for development, to spread good practice and eradicate weaker aspects of learning and teaching.

"High levels of accountability together with coaching and mentoring staff along an 'apprenticeship' model raises the quality of learning and teaching in mathematics."

Self-evaluation works best where these procedures are supplemented by effective analysis and good communication of performance data for evaluating previous performance and planning improvements. Many schools have effective target-setting and tracking procedures and departmental meetings are expected to systematically discuss individual learners' progress towards their targets. In Cynffig Comprehensive School rigorous learner tracking occurs with progress being tracked by each subject leader and head of year. In Bishop Gore and Bishopston very ambitious targets are set for all learners. When learners fall behind the target it is quickly picked up by the form tutor and remedial actions and support set in place.

School leaders fully understand the contribution of mathematics to headline performance indicators such as the **Level 2 threshold including English/Welsh and mathematics** and, more recently, school banding. Consequently many schools have planned and are continuing to plan strategies to improve outcomes in mathematics. Many schools have sought to ensure that the teaching of mathematics throughout the school is carried out by well-qualified subject specialists. A few schools invest in additional staffing at Key Stage 4, either to reduce class sizes or to deploy an extra teacher to work with various groups of learners such as C/D borderline learners or A*/A learners. For example, Bishopston Comprehensive School normally has an eight form entry, but provides ten sets for mathematics at Key Stage 4. Cardiff High School deploys an extra teacher at Key Stage 4 to carry out a 'floating role' working with specific groups of learners. This provision is well-planned, flexible and responsive to the specific requirements of individuals and groups of learners. In several schools, an extra set has been introduced in Year 11 to support C/D grade borderline learners. This has been very successful in raising standards for the school as a whole.

In all the schools there is a high level of **accountability** across all layers of management and across departments. For example in Dyffryn School the head of mathematics views herself as accountable for everything that happens in mathematics. However, she also enjoys her role in drawing the best out of her staff, and views this as fundamental for raising standards in the long term. Dyffryn and Llangatwg emphasised that the nature of the head of mathematics department's role in **developing staff** is very strongly an **'apprentice' model**. This model was also evident in the other schools. Staff learn closely from each other and from strong local networks rather than by simply attending external in-service training courses. This form of staff development is seen as an entitlement.

At Dyffryn the apprenticeship model is summarised in three factors:

- the opportunity to learn systematically from good teachers, concentrating on agreed areas for development
- constantly focusing on the learners and the progress they are making in lessons (not just tests)
- earning the respect of learners and staff – 'then they'll trust the decisions you make are the right ones'.

The head of department at Bishop Gore states that a key aspect is to ensure that teachers develop a thorough understanding of concepts and skills and deploy the best time efficient methods for doing this. It is important that staff do not shy away from teaching difficult concepts and teach for understanding.

Curriculum

"Number, number, number and mental arithmetic – don't assume learners will remember these skills from earlier key stages. Practice makes perfect: use it or lose it."

The GCSE mathematics course is normally taught throughout Key Stage 4. Most schools conform to this pattern, but begin the GCSE course during the summer term of Year 9.

Many schools note that the quality of the Key Stage 3 scheme of work in building effectively towards GCSE is more important than the length of the GCSE course itself. All schools establish a firm basis for understanding number work within Key Stage 3. Several of the schools state that there is a danger in thinking that a firm foundation and understanding of number work and mental arithmetic is established at Key Stage 2 and does not need to be practised regularly at Key Stage 3. Bishopston, for example, has one number lesson every week at Key Stage 3.

Curriculum time allocation for mathematics is usually six or seven hours per fortnight taught in 50 or 60 minute sessions. Schools consider the regular frequency of lessons over the timetable cycle to be important in ensuring that learners can successfully recall and build on work covered in the previous session. The inevitable clustering of lessons on the timetable as a result of collaborative work between providers is recognised as potentially having a negative impact on progress in mathematics. A few schools have successfully planned to ensure that this is kept to a minimum, at least in English/Welsh and mathematics.

All schools have a clear **setting** policy. Most schools set learners by ability early in Year 7 and all schools set learners by the beginning of Year 8. In Newbridge Comprehensive, sets are closely linked to aspirational target levels and grades which the school deems to be central to raising the expectations of learners, parents/carers and staff. A few schools ensure equal ability lower sets so that no-one feels that they are in the 'bottom set'. This again is particularly the case at Newbridge Comprehensive.

The schools have developed different approaches to the **deployment of teachers** to sets. At Ysgol Gyfun Gŵyr the head of department feels strongly that all teachers should be able to teach all sets and abilities. This ensures sustainability and promotes the constant up-skilling of staff. To this end, staff will have a balance of upper, middle and lower ability sets over a two to three year cycle. Equally at Cardiff High teachers rotate between higher and foundation tiers at GCSE so that they retain good course and assessment knowledge. In other schools, for example, John Summers, teachers are deployed according to their strength; some teachers are good at working with top sets and others with borderline C/D learners.

"Developing numeracy systematically across the curriculum supports progress in mathematics."

A proactive approach to the development of **numeracy** across the curriculum supports progress in mathematics. Numeracy is given a high priority in nearly all schools visited. Cynffig Comprehensive School, has established a numeracy focus group which has developed a numeracy toolkit for use across the curriculum. The school has also identified departments other than mathematics to deliver the key skill of Application of Number. **This key skill will be replaced by the numeracy component of Welsh Government's Literacy and Numeracy Framework**.

Tracking and targets

"Tracking linked to skills ladders, knowledge of learners' strengths and weaknesses and where to go next is key to raising expectations … and standards."

All the schools have in place detailed learner tracking systems that link to individual target setting for learners and for groups of learners. In this way the schools can identify exactly what are individual learner's strengths and areas for development. At Cynffig Comprehensive the tracking system is tied to Skills Ladders.

Several schools (including Bishop Gore and Bishopston) have adopted a **global grade** system. All learners receive one grade for their overall progress across all subjects. This grade is aspirational and has raised expectations for all learners. The initial grade is produced from MidYIS in Year 7. The grade ranges from A–E. The grade can only go upwards; only in very exceptional circumstances can it go downwards. All learners and their parents/carers are aware of the grade. Learners are able to share their grade and describe in detail the reviews of their progress. **Progress reviews** take place three times per year. The form teacher reviews the grades for each learner. The learner then attends a review meeting with his/her parents/carers. These sessions can be held at any time of day from 9am up to 7pm so as to fit around the parents'/carers' needs. Parental attendance at these sessions stands currently at between 85 and 90 per cent. At the review meeting discussion takes place as to why a learner is under-performing or over-performing against the generic grade in certain subjects. For example, a learner may have a generic grade of C but be performing at a D grade for English and art. Focused discussion is used to identify three SMART targets for the learner to rectify underperformance. Likewise higher performance than the expected grade is celebrated and a letter of congratulation sent home. Lists of global grades are projected onto a screen during assemblies so that learners can see progress. There are particular lists for Key Stage 4 indicating those learners on track for the Levels 1, 2 thresholds and the Level 2 threshold inclusive of English and mathematics.

Cefn Hengoed uses a similar system. **Teacher assessment** information is entered into a database three times a year together with the end of year examination result. National curriculum sub-levels are used in this process. School makes considerable use of 'Global Grade' information – performance constantly related to this. Should a learner drop below the global grade, the mentoring system will pick this up straight away and form tutor will become involved.

At the same school **examination results** are analysed in detail, with traffic-light question by question analysis which is shared with learners on a spreadsheet. Learners are now thoroughly used to this and are very interested. It is a big motivator for boys, in particular. One-to-one interviews take place with the form tutor on a termly basis. Learners know their target and the interviews have proved successful. The department is keen to develop a way of tracking progress in learners' numeracy skills. It has bought web-based learner licences for from a commercial company and uses this to provide diagnostic assessments in the autumn term in Years 7, 8 and 9. Data analysis informs teaching. Learners each have a target which is reviewed termly and the whole cohort is re-tested in the summer. This is the first year of implementation but it has been very useful and enabled the department to focus on key areas each term (for example, doubling strategies to underpin recall of tables, multiplying and dividing by 10, finding 10 per cent to derive other percentages). Every learner has a numeracy planner in which they track their own progress against the statements in the level descriptors.

Intervention strategies

In the most effective examples, schools provide timely, responsive and flexible intervention for learners across the ability range, but particularly for learners in Years 7 and 8 and for C/D borderline learners in Year 11.

Target-setting and tracking procedures enable the schools to identify learners at risk of underachieving and plan appropriate intervention. In Years 7 and 8 this is particularly effective where close collaboration with feeder primary schools enables departments to provide well-target **withdrawal catch-up programmes** which take account of learners' progress at the end of the primary phase. For more information view the Welsh Government's approved list of catch-up programmes. Where progress data for all learners is collected regularly throughout Key Stages 3 and 4, schools are also able to prompt intervention in place if progress begins to fall behind that necessary for them to achieve their aspirational targets.

"Prompt intervention when learners fall behind is necessary for them to catch up on their target grade."

Intervention in Key Stage 4 usually consists of extra provision during lunchtime, after school or during school holidays and is largely examination-related.

Effective leadership by senior leaders ensures that intervention is given high priority and extra staffing resources are made available. Senior leaders have implemented policies to ensure maximum attendance in these lessons.

Schemes of work

In each of the schools visited, the development of well-constructed and detailed schemes of work for mathematics has been fundamental to setting high expectations and ensuring pace and variety for all learners. It is the key planning document, viewed as 'a scientific bank of knowledge'. None of the schools uses just one **textbook** to teach their GCSE Mathematics courses and, in Llangatwg and Bishop Gore, very little use is made of textbooks at all. Instead, staff usually rely on the scheme of work to steer their planning and assessment and the document is constantly evolving and adjusted – including links made to a wide range of resources.

"The scheme of work is a living, changing document used to meet learners' needs."

Cardiff High modified the scheme of work to ensure learners in the lower sets are able to access the curriculum at an appropriately challenging level. In nearly all schools, thinking and problem skills feature highly in the curriculum design and form part of most lessons. In John Summer there are suites of PowerPoint presentations designed to develop these skills from Year 7 upwards. No set textbook is used in either Key Stages 3 or 4. There is an overarching scheme of work, broken up into half termly topics. Each topic is summarised on an A4 sheet of paper which is displayed in the classroom and given to each learner. Learners give themselves a **Red/Amber/Green rating** against this sheet of paper at the beginning of the module. They then revisit this at the end of the module to see how much they have learnt and how well they have learnt it. The scheme of work is flexible and if a set has difficulty understanding a module, it is worked through more rigorously and the time scale for completing the module is extended until it is understood.

Cefn Hengoed's scheme of work is detailed and provides the direction and detail teachers need. **Minimal use is made of textbooks**, although where they are used they are referenced along with resources and activities developed by the department over time. All members of staff feel a sense of ownership of the scheme of work and time is allocated to adjust it to meet the needs of differing cohorts and year groups. As was the case in nearly all schools, it is in electronic format, to allow for these changes. During the last five years, the scheme has been overhauled so that key skills are embedded in it. However, the head of department states 'we are constantly working on it'. It includes Cognitive Acceleration in Mathematics Education (CAME) lessons, and IT resources such as 'Board Works'. Each member of the department has a particular responsibility in relation to planning, preparation, assessment, exam papers, etc.

Developing a shared teaching philosophy

"High level dialogue and self-evaluation routinely takes place between teachers."

A noticeable feature across all schools is the **high level of dialogue and self-evaluation** that routinely takes place within the mathematics department to evaluate and improve practice in the classroom. Staff continually work together to **refine aspects of the scheme of work** in both Key Stages 3 and 4, with **pedagogy high on the agenda** in department meetings. Heads of department consider this fundamental to securing consistent and effective practice throughout their teams. It has ensured best practice is identified and used to **develop the practice of all members of the department**. **It has increased levels of accountability and raised expectations** for what can be achieved, by both learners and staff.

While learners need to have a coherent experience in all subjects, this is particularly important in mathematics. Each lesson needs to be part of a connected sequence, rather than taught in isolation. To this end, **sharing lesson planning, agreeing approaches to teaching and assessment and discussing common misconceptions and ways to pre-empt these,** have all been central to the work of the departments interviewed.

All heads of department were keen to emphasise the diversity of approaches used over the course of the year, reflecting the focus of different units and the particular make up of the sets being taught. However, the following common characteristics were highlighted in most discussions and seen to be equally important in Key Stage 3 as Key Stage 4.

Figure 6: Common characteristics in developing a shared teaching philosophy

- **Good lesson preparation** – with differentiated activities which appropriately support/challenge all learners.
- **Well-paced, interactive teaching** with frequent opportunities for learners to participate, ask questions and demonstrate understanding.
- **Variety** – balancing **high-quality explanation and modelling** with the whole class with group, paired and individual tasks.
- **Effective questioning** and **frequent opportunities for learners to talk** about their work.
- Systematic development of learners' **mathematical language** and their ability to **explain and record their ideas in a clearly**.

- **Use of mistakes, misconceptions and difficulties** with particular questions as teaching points with the whole class.
- Continued focus on **mental and written number work** (still important in Years 10 and 11).
- Relating mathematics **to real-life applications**.
- **Clear objectives** for each lesson and **summarising the main points at the end**.
- **Homework and assessment feedback seen as an integral part of the learning process**.

In addition, and perhaps most importantly, nearly all heads of mathematics highlighted a strong commitment to improving learners' standards in mathematics by **teaching for understanding** rather than simply teaching rules and techniques. To this end, considerable work has taken place in most departments to develop a culture of **well-structured lessons** which systematically build on learners' prior knowledge and skills and enable learners to derive understanding from **strong visual images and first principles**.

"The quality of questioning makes a big difference to the quality of learning … and of course to the answer."

Similarly, in nearly all cases, significant work has been undertaken as a department to develop the **quality of questioning and discussion**.

Often this has included peer observation leading to changes in department practice which are then a focus within monitoring activities. Effective questioning facilitates high quality discussion. The following aspects of learner dialogue were routinely mentioned during interviews.

Figure 7: Common aspects of learner dialogue

Ensuring as many learners as possible take part

- Using targeted, differentiated questioning of the whole class and named individuals.
- Asking open ended questions so that more learners are able to offer an answer.
- Pausing before taking answers to enable all learners to have time to think.

- Using resources such as digit cards and individual whiteboards to ensure all learners think and respond to all questions.
- Taking answers from several learners, not just waiting for the first 'correct' answer.
- Targeting questioning to identify misconceptions.
- Giving support to learners with specific difficulties.

Ensuring questions are used to assess learners' progress against the teaching objective

- Using questions to probe learners' knowledge and understanding.
- Using the plenary effectively to assess levels of understanding and to prepare for the next lesson.

Planning open and closed questions, and adjusting them as the lesson develops

- Recalling and deriving facts.
- Applying facts.
- Hypothesising and predicting.
- Designing and comparing procedures.
- Interpreting results.
- Applying reasoning.

In a number of schools, the use of CAME approaches has been helpful in developing **problem-solving activities and effective group work**. Where this style of teaching has been embedded throughout the department and permeates all mathematics teaching, heads of mathematics recognise the impact this is having on learners' confidence in tackling non-routine questions at GCSE and PISA-type questions.

Effective ongoing assessment is integral to effective teaching and significant work has taken place in each of the schools (at whole-school and/or department level) to develop and enhance the use made of formative feedback. Through **questioning, discussion and observation, looking at the work learners are doing in the classroom as well as for homework**, departments have sought to evaluate themselves and the breadth of learners'

skills and understanding more effectively. To this end, increasing the amount of **'mathematical talk'** has been beneficial in several schools, with greater emphasis placed on developing **accurate and precise mathematical language**. This has empowered learners, allowing them to understand the technical terms they hear and read more readily and to **explain their ideas and strategies** using appropriate mathematical vocabulary.

Click on the following hyperlinks to see the more detailed case studies.

- Bishop Gore School
- Bishopston Comprehensive School
- Cardiff High School
- Cefn Hengoed Community School
- Cynffig Comprehensive School
- Dyffryn School
- John Summers High School
- Llangatwg Community School
- Michaelston Community College
- Newbridge School
- Ysgol Gyfun Gŵyr.

Preparation for examination

In all schools, a key component of the preparation for GCSE is the attention paid to **marking of past papers and 'forensic' analysis of tests**. Learners receive **diagnostic feedback** to enable them to see what they need to focus on and what they need to do to improve, with time taken during the following lesson to focus on the areas learners found most difficult. This is seen as vital in preparing learners thoroughly for examinations and schools highlight this as one of the main factors in securing good outcomes. Nearly all schools provide extra revision sessions at some stage during the GCSE course, particularly in Year 11. This is done in a variety of ways such as:

- Easter revision sessions
- after school revision sessions or revision clubs
- whole day timetable 'collapse' or suspension for mathematics revision and exam preparation
- 'early bird' revision on the morning of the examination.

Most schools don't permit **study leave** and use this time in school for intensive examination preparation and supervised revision.

"Practising examination papers builds learners' confidence. They learn how to cope with the pressure."

At Ysgol Gyfun Gŵyr additional GCSE revision takes place after school with the classroom teacher on different nights of the week. An assistant headteacher holds an after-school club called the 'C plus' club for those learners taking the Foundation paper in Year 11. The headteacher and head of department are keen to confirm it's impact on the target groups and the positive way in which the assistant headteacher has 'packaged/branded' this club which means learners consider it 'cool' to attend (C = Cool). The notion that 'every person is a mathematician' is fostered in this group' and the headteacher, believes this is a 'powerful success'.

At the same school learners complete numerous past papers in Years 10 and 11. The majority of papers are marked by the teacher and 'model answers' provided in the feedback lesson. Learners discuss these answers generally taking up a whole lesson. Learners are expected to self-assess and to take responsibility for the areas for improvement they need to work on. Many learners make use of revision materials such as MathsWatch and Bite-size to support revision. In Years 10 and 11 staff act as learning coaches to support learners who are at risk of underachieving.

At John Summers learners attend revision sessions during the November half term for early entrants and in May half term for summer entrants. This is felt to be better than the Easter revision week. Additional sessions are held immediately prior to exams.

"By the time learners get to the exam they will have experienced all types of questions."

At Llangatwg Year 11 learners start doing past papers from January onwards. Learners carry out exercises in which they systematically identify the main requirements of questions. Learners receive detailed feedback on these practice papers.

By the time they get to the examination learners will have **experienced all types of questions**. As one member of staff said 'learners will have experienced every type of question they are likely to encounter in the exam, it will just be that the numbers used in the questions will be different. In this way learners should be confident'.

Homework

"In all schools homework is given high priority and used to re-enforce learners' knowledge and understanding."

The amount of homework varies greatly between schools but in all schools homework is given high priority and there is a relentless focus on its completion by all learners. Homework in Key Stage 3 ranges from two or three exam-type questions after **every lesson** at Llangatwg to one extended task per half term in Cefn Hengoed. In Key Stage 4 most schools base homework on exam-type material, supplemented in some schools, by interactive teaching resources such as My Mathematics.

At Cefn Hengoed an extended and more formal piece of homework is given **once a half term**, and incorporates the topics covered during that time. It is not long (2 x A5 sheets of paper) but planned carefully to assess learners' understanding. Teachers give detailed written feedback to every learner and this is a key tracking activity. This is in addition to the homework given each week by the classroom teacher.

In John Summers learners have regular homework which they complete on line. In Key Stage 3 these are made up of online published resources. In Key Stage 4 homework exercises are derived from part examination papers. For learners without internet access at home weekly sessions are organised in the computer suite.

At Bishop Gore there is a relentless focus on learners completing homework – this is a key strand of the strategy for raising standards: it provides essential practice and has had a particularly significant impact on the performance of boys. Three pieces of homework are completed each week (i.e. every lesson).

"There is a relentless focus on the completion of homework."

The head of department is sure that that learners need the individual practice and that this complements the work the learning/teaching that has taken place in the lesson.

Homework is web-based, which means learners do not require photocopied worksheets or texts book. Learners who fail to do their homework report that day to the member of the mathematics department who is timetabled to be in the IT room that day. Some learners actively choose to go to the IT room as it is a calm working environment where there is always a member of the department timetabled to help. The homework tasks are hyperlinked to the scheme of work so all teachers know where to find them and, like the learners, are expected to implement them fastidiously.

Related publications by Estyn and Welsh Government

Improving numeracy at key stage 2 and key stage 3 (Estyn, April 2010)

Numeracy for 14 to 19-year-olds (Estyn, July 2011)

Supporting the more able and talented pupils in secondary schools (Estyn, June 2012)

The Skills Framework at Key Stage 2 – An evaluation of the impact of the non-statutory skills framework for 3 to 19-year-olds in Wales at key stage 2 (Estyn, May 2012)

Tackling poverty and disadvantage in schools: working with the community and other services (Estyn, July 2011)

Money Matters: the provision of financial education for 7 to 19-year-olds in primary and secondary schools in Wales (Estyn, June 2011)

Aiming for Excellence in Key Stage 3 (Welsh Government, October 2012)

Developing thinking skills and assessment for learning (Welsh Government, June 2011)

Bishop Gore School

Context

The head of mathematics has been teaching in the school since 2007 at which time 46 per cent of learners achieved A*–C in mathematics. From the outset she felt it was it was important to work with the department to define good teaching and to unpick the characteristics of an 'outstanding lesson'. This has taken time and by 2011, the percentage achieving A*–C rose to 72 per cent. The department has high expectations and learners know that their teacher will support them and that lessons will be enjoyable: 'Learners know that they will be taught properly and that all staff are serious and committed to the work they do'. Significant staff development has taken place during department meetings which has enabled staff to collaborate in preparing and evaluating lessons and discussing marking in books, the quality of feedback and the progress of learners. The meetings have a distinct 'tutorial' feel and staff value the coaching opportunities they provide.

Planning

The development of a comprehensive scheme of work has been vital in setting the expectations for each set and year group (see Global grades – Moving Window). This was a major undertaking in the first instance and is continually updated in the light of developing practice and resources. However, it has been vital tool in ensuring consistent and effective pedagogy within the department and appropriate pace and challenge for learners throughout Key Stages 3 and 4. Each unit provides guidance on effectively teaching approaches, cross-referenced to key resources and materials within the department (PowerPoints, CAME activities, assessment and homeworks, etc.) The head of department views this as the 'driver' for the work that takes place throughout the school.

Teaching and assessment

During the last five years the department has focused on the 'basics of teaching', with particular emphasis given to the following aspects.

- Effective lesson structure.
- Starter activities related to the previous lesson and/or linked to main part of the lesson (with Years 7/8 also focusing on mental strategies), with 'show me boards' (individual mini-whiteboards) used in every session.
- Teaching focused on the needs of the learner, with frequent paired and grouped work and high levels of discussion. Learners frequently demonstrate solutions on the board, explaining their answers to the class/to the person next to them.
- Open-ended questions – promoting deeper thinking and higher levels of challenge.

- Engaging content – developing 'a sense of enjoyment' and 'learners acting as mathematicians'. All department members have attended CAME training and, subsequently are expected to provide feedback on implementation in the classroom. The head of mathematics has been proactive in monitoring the impact of the training and, as a result, this style of teaching is now routinely used across the department, promoting high levels of discussion, effective group work and meaningful learning.
- Increased collaboration with Learning Support Assistants so that they are prepared beforehand able to provide effective support.
- Opportunities for learners to reflect on their learning, with a plenary that frequently incorporates GCSE-style questions (from Year 8 onwards).
- Use of interactive whiteboards … which have enhanced the pace and structure of lessons. Department collaboration to prepare PowerPoint materials has been valuable in developing a common structure for lessons and scaffolding learners' learning within and across lesson. These PowerPoints are built into the department scheme of work and contain assessment activities and concept cartoons which challenge learners to think, clarify and challenge each others ideas.

Considerable work has taken place to refine assessment approaches and to engage learners in the evaluation of their own work and that of their peers. For example, learners readily work in pairs using and devising mark schemes and this has developed their understanding of the work itself and of the criteria by which they will also be judged. The development of effective questioning has also been a major focus, and teachers continually strive to hone the skills in order to get the best out of the questions they ask.

View the video case study on Learning Wales.

Bishopston Comprehensive School

Context

The school recognises the strong progress made by mathematics over the last ten years and the headteacher describes the department as 'very hard working, rigorous'. Throughout this time the department has been consistently very well-led and managed. There is a 'culture of strong evaluation and follow-through', with all staff committed to improving learners understanding and attainment in mathematics. Department meetings always contain a focus on pedagogy and learner progress and staff are continually swapping of ideas and sharing of resources. As a result, all teachers have good subject knowledge and are able to adapt approached to meet the needs of different age and ability groups.

Planning

The scheme of work is detailed and refined on an annual basis. It is the prime planning and reference document and considerable work has gone into developing and refining it so that it informs department practice. Separate programmes of work exist for each set.

Teaching

- Lessons are characterised by strong teacher exposition and explanation interspersed throughout the lesson with short bursts of activity in which learners work in pairs or groups. 'Mini-plenaries' take place throughout the lesson, rather than a prolonged session at the end. Homework is used to consolidate and practise, hence the lesson is about teaching, dialogue and hands-on activities to develop understanding. The senior teacher (former head of department) describes mathematics lessons as 'high energy lessons – the teacher orchestrates the learning'.
- Lessons are thoroughly planned to ensure good pace and clear expectations for what should be happening at each stage. Learners know they will make progress in mathematics and, as a result, arrive promptly and quickly settle: 'there is always a 'buzz' and sense of purpose at the start of lessons'.
- A mix of approaches is used within and across lessons. Staff are keen to avoid spoon-feeding and strive to ensure lessons provide high levels of challenge and learner engagement – 'learners should be working harder than their teachers in lessons'.
- Lesson starters are used in some lessons in Key Stage 3, although this is not a hard and fast rule and depends on the nature of the work. In Year 7 particular focus is given to developing mental and written calculation strategies so that learners have the number facts and strategies at their finger tips from the start of the key stage.

- Interactive whiteboards and overhead projectors are used where they aid demonstration/ explanation – several teachers have found PowerPoints useful in structuring their lessons and in focusing attention on the key learning points they want to bring out.
- Lessons include problem-solving and group collaboration, the former tending to come towards the end of a topic in order to contextualise the mathematics.
- A range of Assessment for Learning approaches are deployed to gain and evaluate responses, with use of lollipop sticks, for example, to ensure all learners ask and respond to questions. Learners use mini-whiteboards to show answers – there is no longer a 'hands-up' culture in the department as all learners are expected to take part throughout the lesson.

Homework

- Lessons will often start with a brief review of homework – homework is given in every mathematics lesson and considered a key element of the learning process.
- End of topic revision homework is set in Years 7–9, following which learners are given individual targets for improvement. Learners know they will mark each others' work using an agreed mark scheme and then discuss with their partner giving a formative comment. Teachers also mark this homework.
- If a learner fails to complete homework, (s)he has a break or lunch-time detention to do so. Parents/carers are informed if this happens on three occasions. On the whole, this is not an issue. Learners are striving to get GCSE and they recognise the practice-consolidation at home is necessary.
- Learners do a lot of past papers in Years 10 and 11 (16 papers between summer Year 10 and the examination). Every paper is marked by the class teacher and feedback given at individual and class level. 'This is a huge amount of work, but learners can't get mathematics any other way. The learners need to be using what they've learnt in many different contexts so that they are not 'phased' in the exam.' (The school charges a minimum fee toward photocopying).
- Year 11 learners would normally be given study leave and then come back into school for agreed revisions sessions, sometimes arranged at Easter or half-term, dependent on the individual teacher. In 2012, teachers of Year 11 classes will be in their classrooms for all the Year 11 lessons they would usually be teaching so that learners know they can come into school for additional support right up to the exams. This is another step in securing high standards and building learners' confidence before the exam.

View the video case study on Learning Wales.

Cardiff High School

Context

- The Senior Management Team and subject leaders have established a strong lesson observation platform as part of key stage and departmental reviews. Performance management is driven by the departmental improvement plan which, in turn, reflects the School Development Plan. There is a whole-school system for mentoring and coaching teachers, tailored carefully to individual needs.

Planning

- Key Stage 4 is taught by subject specialists. Teachers are rotated between higher and foundation tiers so that they retain good course and assessment understanding. There is a clear setting rationale with over-staffing within mathematics at Key Stage 4 to the equivalent of one extra set to ensure increased support is available where needed. This 'floating role' is perceived as a key factor in success: a mathematics specialist can provide support for groups of learners at any given time. This is not restricted to C/D borderline learners, but is often used for those aspiring to A and A* at GCSE.
- There is a clear more able and talented programme and extra-curricular focus for very high achievers (mathematics challenges, annual conferences). The floating teacher, identified above, often targets further extension work to consolidate highest grades and introduce further challenge.
- Curriculum time: seven hours per fortnight with no early start of GCSE courses in Year 9.
- A good transition programme builds upon the investigative focus of feeder primary schools.
- Schemes of work have a large chunk of number work to establish firm basic skills, recall and number patterns. This is reinforced throughout Key Stage 3 and supported by diagnostic testing (NFER) including non-verbal reasoning. Appropriate intervention and numeracy catch-up is provided using learning support assistants and sixth form students.

Teaching and assessment

- There has been much work at whole-school and department level on developing lesson structure – largely based on a simple three part lesson. Within this structure, teachers are expected to place an emphasis on thinking skills.
- There is a strong whole school emphasis on Assessment for Learning (AfL) and thinking skills which has been particularly well embodied in the mathematics department. An example of problem-solving activities that permeate lessons is learner diagnosis of imperfect answers. This is particularly relevant to diagnosing where credit-worthy responses are gained or lost in exam-type questions at GCSE. Whole-school INSET has

focussed on teaching methodology for eight to ten years, based on staff workshops led by strong practitioners within the school. After about five years the school feels it achieved a critical mass of teachers who were embedding AfL in their work. New recruits receive an induction on AfL and thinking skills so that they become fully aware of the Cardiff High way of teaching.

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Cefn Hengoed Community School

Background

Since the arrival of the current headteacher five years ago there has been substantial re-shaping of processes at all level of leadership and there is clarity of purpose that enables the mathematics department to work in a highly efficient and organised way. The headteacher characterises the department as conscientious and hardworking. They enjoy working with each other, draw on each others' strengths and areas of expertise and operate effectively within the model of distributed leadership which has been developed. The school is founded on strong relationships and high aspirations – 'to know our children is to get the best from them – and learners can see that the department is doing everything it can to enable them to progress in mathematics'.

- The head of mathematics was keen to emphasise, from the outset, that Key Stage 4 'does not exist in a vacuum' and that success for learners relies on a multiplicity of activities and interventions that taken place to ensure every opportunity is seized to support learners from Year 7 all the way to Year 11 (there is no sixth form). 'There is a strong correlation between the work we do from the start of Year 7 and the outcomes of these learners in Year 11'.

Planning

The scheme of work is detailed and provides the direction and detail teachers need. Minimal use is made of text books, although referenced to the scheme of work where useful, along with resources and activities developed by the department over time. All staff have been involved in this process and the document is therefore 'owned' and used by the whole team. It is constantly tweaked and adjusted and during the last five years has been completely updated to incorporate key skills. Each member of the department has a particular responsibility in relation to an aspect of planning/assessment/exam preparation.

Teaching and assessment

- Lively lesson starters are used in all mathematics lessons, with mini white-boards and number fobs employed to engage all learners and gain immediate feedback on the questions asked. The starter activity will often be linked to the skills needed in the lesson. For example, multiplication facts if calculating the size of an area or a simple problem to make learners think and/or provide a link with learners' previous lesson.
- There is a constant focus on the teaching of number skills, continually revisiting and practising skills to help learners retain key number facts and consolidation of mental and written calculation strategies.
- Teachers have high expectations of the learners they teach, and provide frequent positive feedback and encouragement to build learners' confidence.

- A wide range of activities is used to engage learners' interests and promote discussion. This includes concept cartoons, which encourage learners to explain and justify their thinking and CAME style lessons designed to develop group work and collaborative problem-solving.
- In Key Stage 4, sets 1 and 2 learners complete past papers every fortnight from February onwards (prior to this they still covering the content). Learners entering Foundation Tier start past paper earlier as there is less content to get through. All papers are collected and marked rigorously by the class teacher, then discussed in class and common areas of weaknesses reviewed. Modelled answers are provided so pupils have high-quality notes to revise from.

Numeracy

The department is acutely aware of the need to raise standards of basic numeracy and to support learners in gaining at least one recognised qualification in mathematics/numeracy by the time they leave school. To this end, a wide range of approaches are taken, of which the following exemplify some of key strategies developed.

- In 2012–13, in two of the seven lessons all learners have in Year 7 will be 'numeracy' lessons, focusing on number skills. These will be taught by the head of department.
- Nearly every learner achieves Level 2 Application of Number by the end of Year 8, and all six key skills by the end of Year 9. The project has changed this year so that it is more relevant (i.e. buying a first home, rather than sport-focused). This has appealed to boys especially.
- The school is introducing BTEC next year for set 5 (top of Band 2), so some learners will possibly leave with three qualifications in mathematics/numeracy (including GCSE). Everyone will have at least one.
- A strong factor in gaining the 'buy in' of learners is the 'marketing' the department has done. The deputy head described conversations with learners in Key Stage 3 about the value of gaining an Essential Skills Qualification while they are in school.
- The department works hard to include opportunities for learners to practice number skills outside mathematics lessons, including Skills Weeks, World Mathematics Day (Mathetics), Number Fund raising days, Skills Squad (Learner 2 Learner) focus group, mainly Year 7, but some also continue into Year 8).

View the video case study on Learning Wales.

Cynffig Comprehensive School

Context

- Learners enjoy mathematics and there is a good working relationship between teachers and learners. There are high expectations of learners to achieve.
- Between 50 and 60 per cent of Cynffig learners enter the school with basic skills deficits in English and mathematics. By the end of Key Stage 3 successful intervention means that 50 per cent have made sufficient gains to be at a functional literacy and numeracy level.
- There is a whole school 'Cynffig lesson' that includes clear aims and objectives, reference to prior learning and to success criteria. Lessons in all subjects have to embed two key skills. The school was a case study in a recent Estyn thematic inspection on skills for this area of its work. All departments embed literacy as well as using the Cynffig Literacy Toolkit.
- There is systematic mentoring and coaching of teaching staff and learning and teaching assistants.

Planning

- At Key Stage 3 the curriculum builds systematically on the work of the partner primary schools. Estyn stated that the school has sector leading arrangements for developing learners' learning skills.
- The school has devised its own scheme of work which it constantly adjusts.
- The department uses a text book that it has put together for learners.
- Mental arithmetic is used in most lessons and careful and varied use is made of questioning techniques.
- Mathematics is taught for six hours per fortnight. Learners are expected to complete homework on a regular basis.
- Learners are set from Year 7.
- Learners begin to study for GCSE mathematics at the end of Year 9. Learners are put in for early entry and those who score highly and wish to continue to study mathematics for A level start Year 12 provision in Year 11. This provision is led by a member of the Senior Leadership Team. Other high attainment learners continue to work on alternative GCSE mathematics provision.
- Planned revision groups are set in place for learners when required. The school not have study leave for learners but organises in school revision sessions.

Teaching and assessment

- A rigorous learner tracking procedure is in place throughout the school with learners' progress being tracked by subject and by the head of year.
- There is an expectation that all learners will make half a national curriculum level progress per year. In the mathematics department ten learners took AS level while still in Year 11, despite the schools' high levels of socio-economic deprivation.
- Marking of learners' work is detailed and provides diagnostic comments and courses of action.
- Book scrutiny by the head of department identifies areas for improvement or further development. This is particularly the case when a diagnostic test is used as part of the mathematics scheme of work. Teachers place coloured paper in the learners books identifying where the correct answers can be found so that when learners need to revise they are able to identify where to find the correct answers quickly.
- Interim reports on learners are made twice yearly and a full report at the end of the year.
- All learner exercise books have a 'Big Picture to learning' at the front and a 'Ladder to learning' at the back. These link the learner tracking data to the knowledge and skills learner need to learn next or to the areas they need to re-enforce or improve. This is an outstanding feature of the school.

View the video case study on Learning Wales.

Dyffryn School

Context

- The head of mathematics views herself as fully accountable for the standards achieved in mathematics and takes responsible for the professional development of staff within the department – 'drawing the best out her staff is fundamental to raising standards long term'. She is proud of the progress the department has made in recent years and, in a recent survey, mathematics consistently featured amongst the three most popular subjects. Learners believe that they can achieve in mathematics and trust that they will receive the support they need to do so. This is evident in the number of learners seeking additional guidance from their mathematics teacher at lunch-time or after school.

Learning and teaching

- Characteristically lessons include teacher explanation and frequent learner involvement as well as quieter times of reflection and opportunities for learners to practice skills and apply taught strategies until they are confident in using them. Textbooks are used to provide individual learner practice once learners have a clear understanding of the topic they are covering and these are cross-referenced into scheme of work.
- The head of mathematics sees numeracy as a subset of mathematics. As such, the teaching of numeracy skills takes place in mathematics lesson first and foremost before being deployed across the curriculum. Learners' progress in developing mental and written calculations strategies is monitored closely and number skills are continually practised throughout the year to keep them 'on the boil'.
- The systematic development of mathematical vocabulary takes place with all year groups and abilities and has had a significant impact on the quality of learner feedback and classroom dialogue. Learners now have a wider range of mathematical language to draw on and this enables them to articulate their strategies more effectively and to explain their ideas with greater confidence. This in turn helps teachers to assess levels of understanding and plan more effectively for the next stage of their learning.
- The head of mathematics is keen that learners consider themselves to be 'mathematicians' and, to this end, developing their ability to think mathematically is central to the department's approach. All department members have received CAME training and problem-solving and rich tasks are used as part of the general teaching palette. The head of department has been careful to ensure learners are appropriately supported during these lessons rather than allowing learners pursue ideas that may ultimately confuse or undermine understanding.

- Questioning is used routinely to probe learners' understanding and to know where to go next in the teaching. In addition termly assessments take place to assess learners' understanding across a range of topics. Practice is based on learners taking accountability for revising the topics covered during the term and in preparing for the test. Hence learners are used to the formality of testing and keen to have feedback in order to know where they need to focus.
- The Key Stage 4 scheme of work is detailed and linked to GCSE grade criteria. The head of department is a senior moderator for WJEC, having been secondment to WJEC a year or so ago. This has given her intimate knowledge of the syllabus, style of papers, marking scheme, grade boundaries, etc. Teaching, planning and assessment are underpinned by this knowledge, and this expertise is continually shared with staff and learners. This includes clear guidance on methodology marks and, more recently, on the literacy skills learners need in order to pick up additional explanation marks.

View the video case study on Learning Wales.

John Summers High School

Context

Improvement in the mathematics department must be set in the wider context of improvement in the whole school. Six years ago the school was found by Estyn to have serious weaknesses. Following this immediate work was undertaken to focus the school on raising standards and on improving its complete ethos and image.

Improvement in the mathematics department started because the department decided to increase the number of sets in Year 11. An extra set was introduced to support the C/D border liners. This has had a dramatic effect.

The department has a strong ethos that learners must take responsibility for their own learning. The whole school reflects this ethos and uses it to incentivise learners in an area of high socio-economic deprivation.

Planning

- Thinking and problem skills feature highly in the curriculum design and form part of most lessons there are suites of PowerPoint presentations designed to develop these skills from Year 7 upwards.
- No set text book is used in either Key Stages 3 or 4. There is an overarching scheme of work (SoW). The SoW is broken up into half termly topics. Each topic is summarised on an A4 sheet of paper which is displayed in the classroom and given to each learner.
- Learners give themselves a red, amber, green rating against this sheet of paper at the beginning of each topic. They then revisit this at the end of the topic to see how much they have learnt (see the 'Teaching and assessment' section below).
- The SoW is flexible and if a set has difficulty understanding, the skills and knowledge are worked through more rigorously and the timescale for completing the module is extended until it is understood.
- The school considered the modular GCSE but thought it was not appropriate for learners. Their learners were better at working in a concentrated way for an examination rather than keeping up that level of concentration over the two-year study period.

Teaching and assessment

- The department uses half termly assessments/tests, for each topic. Department practice is based on learners taking personal responsibility for revising the topics covered during the half-term and in preparing for the test which draws on the half-term's work. Hence learners are used to the formality of testing and keen to have feedback in order to know where they need to focus in order to improve.

- The tests are carefully marked and three areas for development identified from each. At the end of Year 9 an accumulation of the areas to develop is presented so that learners know what they must address in preparing for GCSE.
- From these tests learners are set national curriculum level targets sub-divided into Level 5.1, 5.2, etc., against carefully defined criteria. These are also shared with parents/carers. The targets set with learners are aspirational. If learners start to fall behind they are given additional support in Tuesday after school sessions and by means of differentiation with lessons.
- The head of department considers learners achieving Level 6+ at end of Key Stage 3 will achieve at least a C at GCSE; those with Level 5 are at risk (borderline). However because of careful targeting in Key Stage 4 last year 18 out of 26 learners who attained Level 5 in Key Stage 3 gained C+ at GCSE. Five out of 28 gaining Level 4 at Key Stage 3 gained a C grade. Learners understand what they have to do to gain each grade in GCSE.

View the video case study on Learning Wales.

Llangatwg Community School

Context

Ten years ago a new head of department (HoD) was appointed. As well as the HoD, two other new members of staff were appointed to the department. There are five FTE staff in the department. The then HoD and another member of the department have since been promoted onto the Senior Management Team but still teach in the department. Work became learner-centred ten years ago and as an immediate result within one year results improved from 42 per cent A*–C to 62 per cent.

The results moved quickly in the first year because of the following.

- Clear identification of department strengths and weaknesses.
- Organisation of the department so that the right member of staff is working to his/her strengths and teaching the appropriate sets. For example, the HoD takes the set with C/D borderline learners.
- Staff observe one another and learn from each other as part of a sharing ethos.
- Work was undertaken on how to manage children's behaviour and learning.
- Staff act as a model for each other and for the learners.
- There is an expectation that the majority of learners will leave with a GCSE in mathematics A*–C.

The ethos of mathematics being fun was introduced. Learners can see that department staff enjoy mathematics. The 'too hard' image of the subject has been removed.

Planning

- The school does not use textbooks. It has a strong scheme of work (SoW) which is constantly being adjusted and altered to improve it. The staff create banks of worksheets.
- The SoW can sometimes be seen as a bible but in reality it is more like a scientific bank of knowledge which is constantly updated and moved on.
- Learners receive energetic and high-impact lessons. Drill and practice form a large part of these lessons. There is pace in lessons and all staff ask themselves how they can better their classroom teaching. There is a visibly strong team ethos in the department.
- Learners are expected to work with pace and effort right from the start of lessons. This is also indicated in the recent inspection report.
- Lessons do not start with a mental arithmetic warm-up session but number work and the recall of number facts permeate all lessons.
- All lessons start with a recap of the work covered in the previous lesson.

- A ‘speed teaching’ technique is used: a rapid exposition takes place, learners talk in pairs about what has just been explained and a learner will then re-explain to the class.
- Learners are asked to make up their own assessment papers as a measure of how well they have understood a topic. For example, Year 7 have just written a test on metric measurements.
- Peer marking takes place.
- Diagnostic feedback to learners is very good.
- Teacher questioning is used to build up learner confidence. Learners will ask the teacher to stop and to re-explain things they do not understand.
- There is constant referral back to previous work.
- There is very little calculator work.
- First three months in Year 7 consists of number work.
- ICT is used where it is proven it will have an impact.
- Practical activities take place where they are useful for strengthening skills and for the introduction of new skills. However, when a new skill is difficult and abstract, for example quadratics, then the rules are taught and drills carried out. The learners have faith that through practice they will eventually understand these difficult concepts.
- Homework is set after every lesson, usually consisting of two to three questions. Learners’ books go home. There are six mathematics lessons with in the ten day timetable.

Assessment and tracking

- The school tracking system has just received praise in the inspection report. The tracking allows the schools to map across the core subjects at Key Stage 4.
- Rigorous targets are set for each mathematics set.
- Fisher Family Trust data is used as a guide but not a ceiling. Data provides a baseline but it is the quality of teaching that counts. Data acts again at the end of the year to confirm the quality of learning and teaching.
- Learners have a clear knowledge of what constitutes each grade at GCSE mathematics. They know their strengths and the target areas where they must improve their performance.
- The SoW identifies two formal assessment opportunities every half-term from Year 7 upwards. These assessment topics will eventually form part of the end of year examination. Learners clearly understand this and know how important it is for them to understand each topic. When learners identify that they do not have a firm grasp of one of the topics or when their assessment indicates this it is used by staff as a trigger for intervention and the topic will be re-visited.

View the video case study on Learning Wales.

Michaelston Community College

Context

- Learners enjoy mathematics in the school. The relationships between staff and learners are excellent and this is reflected in the behaviour of the learners within the department. The recent use of a specialist teaching assistant has helped raise the profile of mathematics.
- At Key Stage 3 lessons are more structured, learners know what is expected and the lesson begins as soon as they enter the classroom. Mini white-boards are used frequently and this maintains the pace and keeps learners motivated. At both key stages the department vary the working styles expected in lessons to give every opportunity for independent learning, paired or group work. Learners are willing to share their answers and will frequently share their answer via the interactive white board. Learners are encouraged to make up questions including an answer and ask their peers to answer them.

Planning

- Setting is purely on academic ability. This has a positive impact on disruptive learners who feel a sense of worth and therefore perform academically. All teachers within the department have been rated good by Estyn and every year all staff have a variety of different ability sets. This has allowed them over to be multi-skilled and good at teaching any group of learners. The top two sets are known as higher and the remainder of the sets are known as foundation. This is keeping in line with the tier of entry at GCSE. There is movement between the sets after each assessment. This motivates learners.
- The schemes of learning (SoL) at Key Stage 3 enable the department to have consistent use of mathematical language and we are very particular in the way questions are answered. Accuracy and presentation is the key. The learners must always be mathematically correct in everything they do.
- At the start of a lesson there is always a recap of the previous lesson. When starting a new topic learners are reminded of prior learning.

Teaching and assessment

- Different styles of pedagogy are used depending on the learner's ability. Every lesson has a learning outcome, a starter activity if required. The starter is either a recap of the previous lesson or an activity that addresses learner's weakness. The main body of the lesson is designed to have less teacher talk and more of the learners learning with many mini plenaries and opportunities for reflection. The SoL enables learners to access harder topics from Year 7. Year 9s follow the GCSE syllabus which enables all learners to study GCSE over a three year period. Therefore the follow through between Key Stages 3 and 4 is relatively painless.

- After every main assessment, one per term, the department analyses the examinations of each class. The next term's work focuses on the common mistakes made by each class. More recently the department has had a programme of intervention and withdrawal led by a specialist teaching assistant.

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Newbridge School

Context

The current head has worked hard on building the learning and work ethos of the whole school. Staff clearly model the expected ethos and behaviours. The approach she brings is that 'we are all here to work and have core business to get through'. Other whole school factors that positively influence mathematics are mid-year reviews with heads of department, annual department reviews, support from senior data manager and the provision of essential skills at Key Stage 4 for all learners. Learners' understanding of targets is very evident and striking. Classes are introduced as 'aiming for C grade', or 'aiming for A* grade' for the highest set. Fisher Family Trust model D facilitates are used for learner target-setting. The department populates and has easy access to an individual learner tracker which is hosted on SIMS Assessment Manager.

Planning

- Schemes of work are very carefully planned around progression and there is a very sequential approach to introducing new concepts and the amalgamation of skills.
- The head of department sees a natural continuum from Year 9 into Key Stage 4 and designs the Key Stage 3 scheme of work carefully to provide a sound basis for Key Stage 4 and a seamless progression from one to the other. A good example is Year 7 provision being designed to provide a sound number base upon which to build.

Teaching and assessment

- Learners are well cared for within the mathematics department and feel in safe hands. There is a clear philosophy that 'there are no problems, just solutions' and an expectation that all learners make good progress in all lessons. There is continuous and persistent use of positive language such as 'no ceilings' and 'personal best' and the refining of best teaching practice by regular reflective discussions.
- There is overstaffing of mathematics at Key Stage 4 (five sets + support group). Again, the support group isn't necessarily for lower abilities, but is deployed flexibly according to need, concluding at A* and A grades.
- Learners are constantly prompted to discuss and verbalise using mathematical language.
- The department pays close attention to correct mathematical notation and on how to access full marks for questions. Peer marking and self-marking are integral to lessons and occur every 15 minutes or so. The school has adopted a 'green pen' self-correction policy whereupon learners will be given time to correct their responses in green pen after receiving an explanation so that they can more easily track their own potential pitfalls and how they can be overcome. This personalises school work and provides a strong sense of ownership and empowerment.

- Lesson structure is roughly based on an Initial Teacher Training (student teacher) model which the school feels works well. The approach to tackling mathematics questions is read, decide on a formula, substitute, calculate. This 'four step' mantra is constantly drilled into learners.
- Late revision classes up to the day of the examination are used to drill the recall aspects that are required. (There is some frustration that the GCSE mathematics paper is after half-term and may affect outcomes.)

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Ysgol Gyfun Gŵyr

Context

The headteacher describes the mathematics department as 'very traditional' in many ways, with long standing members of staff who work very hard, bringing rigour to teaching and assessing in the classroom. 'Staff are constantly looking at ways to enhance learning and teaching, building in what works and tweaking the basics.'

The head of department is fervent in his desire for learners to reach their full potential in mathematics and to enjoy the subject because they are confident and understand what they are doing, rather than relying on tricks and 'gimmicks'. The latter can enable learners to complete exercises during the lesson, without developing the skills needs to apply mathematics in non-routine and real-life contexts.

Learning and teaching

- The department views GCSE as a five year journey from Year 7 to Year 11 – 'performance in Key Stage 4 cannot be divorced from all the work that comes before it'. To this end, the department seeks to instil a strong work ethnic from the outset and to support learners in taking increasing accountable for the progress they make throughout the school. Learners are expected to work hard in lessons and the department is keen to avoid 'spoon-feeding'. However, lessons are characterised by frequent praise and positive feedback that seeks to build learners' confidence and counter parental and society views that mathematics is too difficult for most people.
- Teaching approaches in Key Stage 4 are similar to those used in Key Stage 3 – underpinned by a shared philosophy to develop learners' grasp of the 'big ideas in mathematics' and to make connections across different areas of the subject. For example, securing learners' understanding of the place value (such as multiplying and dividing by 10 and 100) and their ability to use the relationship between fractions, decimals and ercentages are seen as vitally important to learners' progress in mathematics.
- The department has become increasingly aware of the loss of marks at GCSE due to weaknesses in learners' number skills. This has further sharpened the focus on number work throughout the school. As a result, staff closely monitor learners' ability to recall key number facts and to carry out mental and written calculations. Additional support is provided, where needed, to ensure all learners acquire the 'basic building blocks'.
- Questioning is central to all mathematics lessons. All staff have attended CAME training and this has helped the department to refine questioning techniques and incorporate problem-solving and collaborative work on a regular basis. As a result, teachers are less likely to settle for the first 'correct' answer given, instead probing for understanding and opening up discussion and reflection.

- Learners are encouraged to thing logically and draw on worked examples when completing questions and revising for assessments. Similarly, significant use is made of modelled answers in Key Stage 4 which learners use as part of peer and self-assessment processes.
- The whole school five-part lesson format is embedded within department planning: aims of the lesson, exposition, practise, review and reflection. Learners are expected to demonstrate on the board and to explain their thinking. The plenary includes homework preparation.
- Homework is given high status within the department and all learners have a homework file which they build up throughout the year from to revise and to identify areas to focus on. There is an expectation that homework is done the evening it is given so that learners have an opportunity to ask for help before bringing it to the lesson.
- A key component of the preparation for GCSE is the attention paid to marking of past papers and 'forensic' analysis of tests. Learners complete numerous past papers in Years 10 and 11. The majority of papers are marked by the teacher and 'model answers' provided in the feedback lesson which learners discuss (generally takes a whole lesson). Learners are expected to self-assess and to take responsibility for the areas they need to work on.
- The department has an open-door policy which enables learners to ask for additional help at break, lunch time and after school. Additional GCSE revision takes place during the 'C plus' club (C = Cool) which targets learners taking the Foundation paper in Year 11. Care has been taken to 'brand' this club as one which learners want to attend and subscribe to the belief that every person is a mathematician. It contributes effectively to the work of the department in providing targeted support for those who may otherwise struggle to achieve C or above in Year 11.

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