Teaching and Learning Science

Teaching for understanding in science classrooms

June 2026

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Executive summary

This thematic report examines the quality of teaching and learning in science in primary, secondary and all-age schools in Wales. It evaluates how well schools are developing pupils' scientific knowledge, understanding and enquiry skills as part of the Science and Technology Area of Learning and Experience (Area) within the Curriculum for Wales for the 7-16 age range. The report considers the effectiveness of curriculum design, teaching, assessment and leadership, and how well schools support progression in science across phases. It also explores pupils' attitudes towards science and how well they apply their learning in authentic contexts.

The report highlights examples of effective practice in the primary and secondary phases, where schools have developed coherent curriculum plans, strengthened subject expertise and supported pupils to deepen their understanding of scientific concepts over time. However, across the schools visited, the quality of provision for science is inconsistent. In too many cases, weaknesses in curriculum design, teaching and assessment limit pupils' progress, particularly in developing secure conceptual understanding and scientific reasoning. Arrangements to support progression between the primary and secondary phases are often underdeveloped, leading to repetition, gaps in learning and uneven challenge.

This report evaluates four key areas:

- **Science in the primary phase**: A majority of primary schools are increasingly ambitious in their approach to science and provide pupils with engaging, practical learning experiences that foster curiosity and enjoyment. In the strongest practice, leaders have developed clear progression models that balance enquiry with the explicit teaching of scientific knowledge and provide meaningful real-world contexts, often through partnerships with industry and the community. However, in a minority of schools, science does not have a sufficiently high status within the curriculum. Over-reliance on thematic or enquiry-led approaches, without clear planning for conceptual progression, results in pupils completing activities without fully understanding the scientific ideas underpinning their work. Assessment and tracking of pupils' scientific understanding are often underdeveloped, making it difficult for leaders to evaluate progress over time.
- **Science in the secondary phase**: In most secondary schools, curriculum plans are structured around disciplinary approaches to biology, chemistry and physics, supporting appropriate coverage and examination preparation. Where teaching is strongest, teachers use secure subject knowledge, effective modelling and questioning to develop pupils' conceptual understanding and scientific reasoning. However, in a minority of schools, weaknesses in planning mean that learning is not sequenced clearly enough to develop pupils' knowledge and skills systematically over time, particularly in Year 7 to Year 9. Limited curriculum time, staffing challenges and inconsistent collaboration with

primary schools contribute to variability in pupils' experiences and progress.

- **Understanding progression in science**: Across both phases, schools are at different stages in developing a shared understanding of progression in science. In the strongest examples, leaders use collaboration documents and shared expectations of progression to support continuity, revisit key concepts and address misconceptions systematically. However, in a majority of schools, progression is not planned securely enough. Teachers often address misconceptions reactively rather than anticipating them through curriculum design, and assessment does not consistently capture how pupils' understanding deepens over time.
- **Leading and improving science**: Effective leadership is a key factor in securing strong science provision. In schools where leaders prioritise science, protect curriculum time and invest in subject-specific professional learning, pupils benefit from more coherent curricula and stronger teaching. However, in many schools, the monitoring and evaluation of science focuses too heavily on provision rather than its impact on learning. Challenges in recruiting and retaining specialist science teachers, particularly in Welsh-medium settings, continue to affect provision.

Across the schools visited, the strongest teaching in science shares a number of common features. These features reflect the ways in which teachers support pupils to develop secure conceptual understanding and apply their learning over time. They are summarised below.

Subject knowledge: Teachers use strong subject knowledge to shape learning

- Teachers provide accurate explanations and use precise scientific vocabulary
- Teaching draws on well-chosen examples that highlight key concepts
- Teachers anticipate and address common misconceptions

Sequenced progression: Learning is designed to build cumulatively over time

- Curriculum design support a logical sequence of scientific ideas
- Teachers revisit important concepts to extend and refine pupils' understanding
- Learning provides appropriate challenge, increasing in complexity and independence over time

Conceptual understanding: Pupils develop secure understanding of key scientific ideas

- Learning focuses on the most important scientific concepts
- Pupils make connections between ideas and build coherent understanding
- Pupils explain their thinking clearly using appropriate scientific language

Purposeful teaching: Teaching supports pupils to develop and apply understanding

- Teachers ensure pupils have understood and have secure knowledge before they apply their learning
- Teachers integrate theoretical understanding with practical work so that pupils develop a secure understanding of underlying scientific concepts
- Teachers intervene at appropriate points to address errors and deepen pupils' thinking

Responsive assessment: Assessment informs teaching and supports understanding

- Teachers use questioning and discussion to probe pupils' thinking
- Assessment identifies misconceptions and gaps in understanding
- Teaching in adapted in response to pupils' understanding

Real-world application: Learning is extended through meaningful contexts

- Teachers select contexts that support understanding of scientific ideas
- Pupils apply their knowledge in a range of relevant situations
- Learning helps pupils recognise the relevance of science beyond the classroom

This report makes recommendations for schools, local authorities and school improvement services, and the Welsh Government. These recommendations focus on strengthening curriculum planning for progression, improving the quality of teaching and assessment, developing leadership capacity in science, and addressing workforce and professional learning challenges to ensure that all pupils in Wales experience high-quality science education.

Introduction

This report has been prepared in response to a request from the Welsh Government, as outlined in Estyn's annual remit for 2025-2026. It focuses on the teaching and learning of science in primary, secondary and all-age schools in Wales across the 7-16 age range. The aim of the report is to provide an insight into the strengths and areas for improvement in how schools plan for and teach science. It highlights examples of effective practice in the schools we visited and provides support for teachers and leaders to evaluate their schools' provision for science as part of Curriculum for Wales. The review explores the four key areas:

- **Science in the primary phase**: the different ways in which primary schools plan and deliver science, and how the teaching and learning of science develops across the primary phase, including the balance between practical enquiry and the development of scientific knowledge and understanding.
- **Science in the secondary phase**: how teachers and leaders in the secondary phase organise the science curriculum, ensure appropriate coverage and progression across the Area of Learning and Experiences, and the quality of teaching and learning in science classrooms.
- **Understanding progression in science**: how well leaders and teachers plan for progression in scientific knowledge, skills and understanding, how effectively they build on pupils' prior learning, and how teaching addresses misconceptions and supports the application of scientific knowledge over time.
- **Leading and improving science**: how leaders in the primary and secondary phases support and improve science provision, including curriculum time, staffing and professional learning, and how partners and wider system contribute to the development of science education.

This report was informed through a variety of evidence gathering activities including:

- Visits to schools: We visited 16 primary schools, 19 secondary schools and 4 all-age schools. During our visits we interviewed leaders, teachers and pupils and we observed the teaching of science.
- Meeting with other stakeholders: We met with a variety of stakeholders including representatives from local authorities and regional support services, initial teacher education (ITE) providers and Adnodd.
- Findings from Estyn's inspection evidence.

More detailed information about the evidence base for this report can be found in the methodology section in the appendices. This report is intended for the Welsh Government, local authorities, school improvement services, teachers and leaders in schools and other organisations that support the learning of science in Wales.

Background

The Estyn report *Science at key stage 3 and key stage 4* (September 2017) presented a mixed picture of science education in Wales, highlighting both strong outcomes and persistent challenges. The report highlighted that science remained the highest-attaining core subject at the end of Year 11, with generally positive GCSE performance over time. However, pupils' progress in Years 7 to 9 was less consistent, with expectations often too low and insufficient challenge for more able learners. The report identified variability in teaching quality between and within schools, limited opportunities for pupils to develop higher-order scientific enquiry skills, and growing pressures on curriculum time. Despite improving national outcomes, international evidence from The Programme for International Student Assessment (PISA) (2015), as quoted in Estyn (2017), indicated a long-term decline in science performance, particularly among higher-attaining pupils. The report also highlighted continuing issues around equity, leadership clarity and workforce capacity, including difficulties in recruiting and retaining specialist science teachers.

Key findings from the 2017 Estyn science report

- Progress and standards: Pupils generally made stronger progress in Year 10 and Year 11 than in Year 7 to Year 9, where expectations were often too low, particularly for more able learners.
- Teaching quality: Teaching was stronger in Year 10 and Year 11, while weaker lessons - more common in Year 7 to Year 9 - relied heavily on low-level tasks and worksheets.
- Scientific enquiry: Many pupils had limited opportunities to plan, evaluate and design investigations independently, restricting the development of deeper scientific understanding.
- Attainment and equity: Overall GCSE outcomes were strong, but gaps persisted between boys and girls and between pupils eligible for free school meals and their peers, with little improvement in the proportion achieving the highest grades.
- International performance: PISA outcomes showed a sustained decline in science performance since 2006, driven largely by weaker outcomes among higher-attaining pupils.
- Curriculum and staffing: Reduced curriculum time at key stage 4 and ongoing challenges in recruiting specialist science teachers, particularly in Welsh-medium and rural schools, continued to affect provision.

The Estyn report Science and design and technology at key stage 2 (July 2017) found that many pupils in Wales achieve well in science by the end of Year 6 and develop a secure understanding of basic scientific concepts, supported by generally positive attitudes towards practical work. However, the report highlighted variability in teaching quality, assessment and leadership, alongside weaknesses in pupils' investigative skills, particularly in evaluating evidence, drawing conclusions and using data accurately.

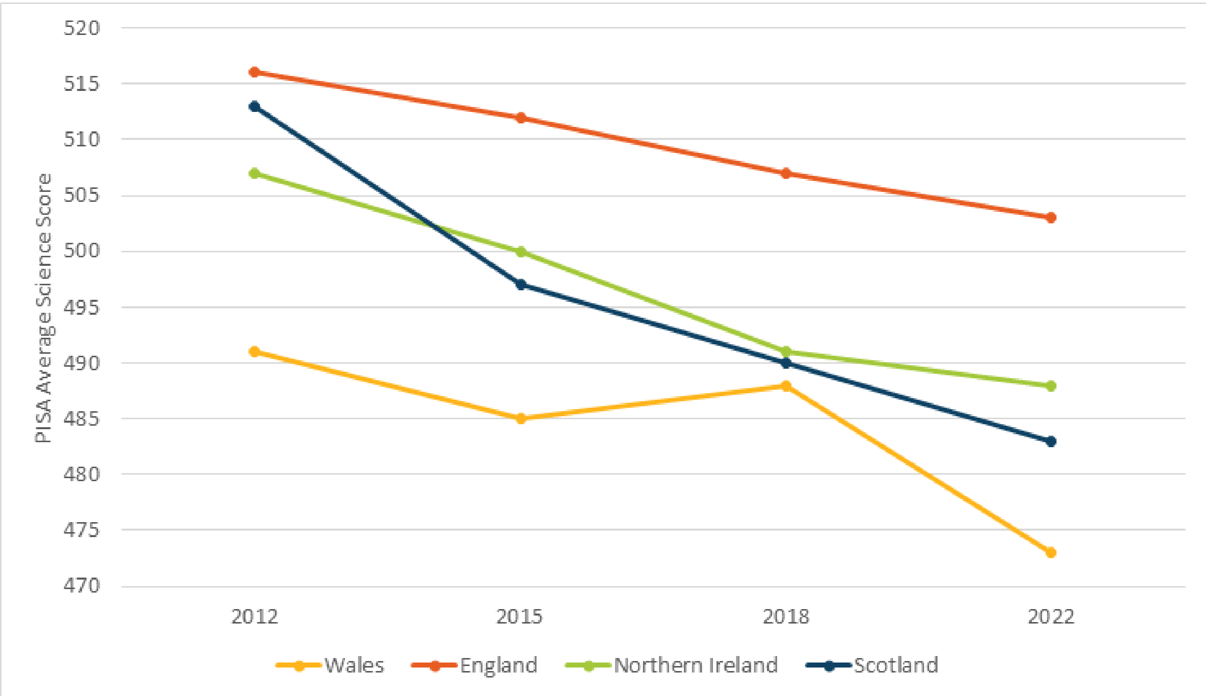
Although outcomes in science have improved over time, substantial attainment gaps persist for pupils eligible for free school meals, especially at the higher levels. Inconsistent curriculum time, limited challenge for more able pupils and insufficient subject-specific professional learning for teachers were also identified as ongoing issues.

Standards in science in Wales

International evidence also provides important context for science education in Wales. The Programme for International Student Assessment, conducted by the Organisation for Economic Co-operation and Development (OECD), assesses the scientific literacy of 15-year-olds, focusing on their ability to apply scientific knowledge and reasoning in real-world contexts. Evidence from PISA (2022) as quoted in PISA 2022: National Report for Wales, indicates Wales' performance in science was below the OECD average and lower than that of other UK nations, with a decline in performance compared with 2018. Welsh Government commentary has highlighted the impact of the COVID-19 pandemic on pupils' outcomes, particularly for those from disadvantaged backgrounds. These findings reinforce the importance of high-quality science teaching that develops pupils' understanding, reasoning and application of scientific knowledge over time.

Chart 1, below, shows that between 2012 and 2022, the performance of Welsh pupils in science has declined in Wales and on average across the UK.

Chart 1: Trends in science



Curriculum reform – a change in context

The introduction of Curriculum for Wales (Welsh Government, 2022) represented a shift in expectations for science education. Science sits within the Science and Technology Area of Learning and Experience (Area) (Welsh Government, 2022), alongside design and technology and computer science. Statutory guidance emphasises the importance of developing learners' scientific knowledge and understanding alongside enquiry skills, enabling learners to ask questions, test ideas and apply learning in meaningful contexts. The Statements of What Matters highlight that understanding scientific concepts and processes should deepen over time, rather than focusing on the coverage of isolated topics.

This thematic report considers the quality of provision for science in the primary and secondary phase and how well schools are working together to plan for pupil progress and ensure pupils develop a deeper understanding of science over time.

Recommendations

Schools should:

Improve the quality of teaching in science by strengthening teachers' pedagogical subject knowledge.

Strengthen curriculum planning to ensure that science learning is coherent, enabling pupils to build their knowledge and understanding systematically over time while developing independence, scientific reasoning and deeper conceptual understanding.

Strengthen leadership and improvement processes in science so that leaders evaluate the impact of provision on pupils' learning and ensure that there is enough time, expertise and support allocated to the subject.

Strengthen collaboration between primary and secondary colleagues to agree and implement shared curricular expectations in science, improving coherence, progression and continuity in pupils' learning.

Local authorities and school improvement services should:

Strengthen science-specific professional learning to improve teachers' subject knowledge, including targeted support for Welsh-medium provision and non-specialist teachers.

Improve cluster collaboration so that schools develop a shared understanding of progression and ensure smoother continuity in learning from primary to secondary.

Establish regional professional learning networks in physics and chemistry to build specialist capacity, especially in Welsh-medium schools.

Welsh Government should:

Provide clear direction to Dysgu and other partners for developing science-specific professional learning, to provide a sustained programme of support for all science teachers, including those working through the medium of Welsh.

To support high expectations in science, develop clearer definitions of progression outlining how knowledge, enquiry skills and understanding should develop and be sequenced across phases.

Strengthen system-level approaches to address science teacher shortages and build the capacity of Welsh-speaking teachers to teach science with confidence and fluency.

Strengthen Welsh-medium science provision by improving access to high-quality Welsh-language resources, working with national partners such as Adnodd, and supporting consistency in scientific terminology and subject-specific professional learning.

The science curriculum in the primary phase

Curriculum Planning

In the majority of primary schools visited, curriculum planning for science is ambitious and increasingly well structured. As a result, these schools are developing clear progression models that effectively sequence scientific knowledge and skills coherently across year groups. In the strongest examples leaders have created detailed long-term plans and shared progression frameworks outlining the progressive development of pupils' scientific knowledge and understanding. They have often worked collaboratively with cluster partners or other secondary schools to develop shared curriculum frameworks. Evidence from collaboration documents indicates that this joint work is increasingly helping to improve continuity in learning raising expectations across phases, particularly where these documents establish a shared understanding of what pupils should know and be able to do at different stages. Where primary curriculum planning is informed by these shared cross-phase expectations, gaps in learners' scientific understanding are less likely and progression is more secure. In a minority of schools, however, schemes of work are insufficiently specific to support teachers in identifying clear conceptual progression year on year, limiting the development of pupils' scientific understanding over time.

The time allocated to science and its status within the curriculum varies across the primary schools sampled. In a majority of schools, leaders ensure that science has a clear and purposeful place within the curriculum, with regular opportunities for pupils to develop their knowledge and understanding either through discrete lessons or well-planned integration within thematic work. In these schools, leaders signal the importance of science through curriculum planning, progression frameworks and enrichment activities, which helps maintain its profile. However, in a minority of schools, the requirements of Curriculum for Wales are not considered well enough and the time pupils spend on science fluctuates depending on the focus of whole-school themes. In these cases, science is taught only when it aligns closely with a topic, resulting in irregular provision and a lack of opportunities to secure progression. Gaps in conceptual understanding most commonly arise where science is delivered predominantly through thematic or enquiry-led approaches without sufficiently planning for pupils' development. In these contexts, medium-term plans often prioritise engagement and coverage over clarity about the specific scientific knowledge and understanding pupils should secure. This results in uneven depth in learning and occasional omission of key concepts.

Where science does not have a consistently high profile in a school's curriculum, pupils' experience variable time allocation and teachers sometimes need to revisit or 'backfill' missed learning in later years. Overall, while many schools are committed to strengthening science within their curriculum, in a minority of schools, insufficient time allocation and curriculum structures do not reflect the importance of science as a fundamental area of learning.

Authentic contexts and purposeful curriculum design

Many primary schools use authentic and engaging contexts effectively to increase motivation and make learning relevant. In these schools, science learning is frequently rooted in real-world issues, such as environmental sustainability, local industry, or community-based projects, helping pupils see science as purposeful rather than only abstract. For example, pupils apply their scientific knowledge through outdoor learning, environmental investigations and industry-linked projects, connecting classroom learning with real-life applications. In the most effective practice, these contexts are carefully chosen to support conceptual understanding rather than acting as a superficial hook. This allows pupils to apply and deepen their knowledge through scientific enquiry, including investigation, evidence analysis, reasoning and problem-solving in meaningful ways. In a minority of schools, however, these contexts are not aligned closely enough with the intended learning, which limits their impact on pupils' developing scientific understanding.

Strengthening science through collaborative curriculum design and purposeful learning

At **Beaufort Hill Primary School**, leaders have ensured that science retains a high profile through a clear strategic vision and strong collaboration beyond the school. Working closely with cluster partners, the secondary school and the regional consortium, leaders have co-developed a shared science curriculum underpinned by progression ladders. This collaborative approach supports continuity for pupils as they move into Year 7, while allowing the school to adapt learning to reflect its own context and community.

Science learning is embedded within thematic units and enriched through carefully planned immersive experiences. Leaders use launch events, such as Explorer Dome visits or drama-led workshops, to capture pupils' interest and establish clear purposes for learning. These experiences are followed by enterprise projects and end-of-unit showcases, including initiatives such as a honey shop or beeswax enterprise, which provide pupils with authentic audiences and meaningful outcomes. As a result, pupils see science as relevant, engaging and connected to real-life applications.

Leaders further enhance provision through a wide range of enrichment activities, including Science, Technology, Engineering and Mathematics (STEM) clubs, careers events and community partnerships, which raise pupils' aspirations and broaden their understanding of science-related pathways. Regular monitoring through Area teams, supported by governor involvement, ensures that science remains a strategic priority. Ongoing cluster discussions enable leaders to reflect collectively on shared priorities, such as strengthening investigative skills and scientific vocabulary.

As the curriculum continues to embed, leaders are now evaluating its impact on pupils' learning more closely. They have identified the need to refine planning to ensure a balance between breadth and a sharper focus on the scientific knowledge and concepts that matter most. This reflective approach demonstrates the school's commitment to continuous improvement and to securing high-quality science learning for all pupils.

Approaches to delivering science

In the majority of primary schools visited, schools plan a range of teaching approaches to deliver science, although these approaches are not always combined effectively to support pupils' learning. In a minority of schools, teachers use a well-judged blend of direct instruction, guided practice and enquiry-based learning, which helps pupils secure key scientific knowledge before applying it through investigation. In these schools, pupils develop a clear understanding of scientific concepts and are able to explain their thinking. In a majority of schools, enquiry-based approaches feature prominently and contribute positively to pupils' engagement and motivation.

In a minority of schools, enquiry is overemphasised without sufficient prior conceptual input. This results in pupils completing investigations without fully understanding the underlying science. In a few schools, teaching focuses too heavily on task completion or activity sequences, which limits opportunities for pupils to deepen their knowledge over time. Where secondary science specialists work collaboratively with primary teachers, this supports more effective integration of enquiry and conceptual teaching in science. Where planning is most effective, teachers adapt their approach flexibly, allowing extended time for exploration when appropriate while also intervening to clarify misconceptions and secure learning. Overall, although schools employ a variety of pedagogical approaches, in a minority of cases enquiry learning does not consistently support the systematic development of pupils' subject knowledge.

Building a science curriculum through awe and wonder

At Maindee Primary School, leaders have deliberately placed awe, wonder and curiosity at the centre of their science curriculum, using these principles to engage pupils and inspire meaningful scientific enquiry. This approach is rooted in the Science and Technology Area, particularly the emphasis on nurturing curiosity and encouraging pupils to explore and make sense of the world around them.

Leaders use rich, first-hand experiences as entry points for learning. Visits to farms, markets and local environments provide memorable contexts that stimulate questions, predictions and discussion. Activities such as gardening, cooking and food production are planned progressively across year groups, enabling pupils to revisit and deepen scientific knowledge and skills over time rather than experiencing science as isolated events.

To support consistency and progression, the school has developed practical planning tools, including progression maps, enquiry frameworks and the 'rainbow tool', which helps staff consider the range of learning across biology, chemistry and physics. These tools support teachers in identifying gaps in pupils' understanding, ensuring appropriate breadth and planning opportunities to revisit concepts with increasing depth. Leaders also recognise the importance of discrete science teaching alongside enquiry-based learning to secure key knowledge before application.

The school's involvement in the Thinking Schools project further strengthens this work. Leaders involved felt that thinking routines and questioning frameworks helped pupils articulate ideas, structure investigations and reflect on outcomes, supporting the development of more disciplined scientific thinking.

This approach helps to motivate pupils, broaden experiences and support purposeful, inclusive engagement with science.

In a majority of primary schools, leaders have planned opportunities for pupils to return to key scientific ideas, for example through two-year cycles or repeated themes with structured progression that includes increasing aspirations of what pupils can achieve. This supports pupils to consolidate prior learning and extend their understanding at increasing levels of complexity. In the strongest practice, teachers deliberately revisit concepts such as materials, forces or electricity, enabling pupils to refine their skills and deepen conceptual understanding rather than encountering topics as one-off experiences. When these approaches are most effective, leaders ensure that revisits are purposeful, clearly linked to progression expectations and informed by prior learning. This supports pupils well to make secure and sustained progress. In a minority of schools, teachers do not plan well enough for the progressive development of pupils' knowledge and conceptual understanding. In these cases, while pupils' experiences are often engaging, they do not always build understanding over time.

Revisiting and deepening scientific concepts through purposeful curriculum design

At **Henllys CIW Primary School**, leaders have designed a science curriculum that deliberately revisits and extends key concepts, enabling pupils to develop secure and progressive scientific understanding. Long-term planning is underpinned by clear progression pathways and detailed 'I can' statements, which help staff identify how learning should build over time and ensure pupils experience science as a coherent sequence rather than isolated topics.

Leaders plan purposefully for pupils to return to important scientific ideas at greater depth. For example, pupils first explore simple electrical circuits in Year 4, developing foundational understanding of components such as bulbs and switches. This learning is revisited in Year 6, where pupils extend their knowledge by measuring current and resistance and applying it to create working Morse code systems. Linking this work to a World War II history topic helps pupils understand the real-world application of science and strengthens cross-curricular connections.

A similar approach is evident in pupils' learning about forces. Building on prior work, Year 6 pupils investigate air resistance and stability by designing and testing parachutes. An RAF parachute instructor provides an authentic stimulus and introduces pupils to science-related careers. Pupils test variables such as material and size, apply fair-testing principles, and use ambitious scientific vocabulary accurately, supported by opportunities to analyse data and discuss findings using literacy and numeracy skills.

This planned revisiting of concepts supports pupils to consolidate prior learning while extending their understanding meaningfully. By combining progressive curriculum design with authentic, cross-curricular contexts, leaders ensure pupils deepen their scientific knowledge and recognise science as relevant, purposeful and inspiring.

Across the schools visited, teachers' expertise and access to suitable resources varies. This has a direct influence on the quality and coherence of curriculum planning in science. In a majority of schools, science leaders support planning effectively by providing clear progression frameworks, agreed content expectations and practical guidance, which helps teachers plan science with increasing confidence and consistency. However, in a minority of schools, insufficient attention to developing teachers' subject knowledge results in planning that prioritises activities pupils will complete rather than on the scientific concepts they are expected to understand or on the progressive development of scientific skills. In a minority of primary schools, regular joint planning with secondary specialists, alongside shared professional learning strengthens planning for progression. In a few schools, limited access to high-quality resources further constrains planning, particularly in Welsh-medium settings where suitable science materials are less readily available.

The quality of assessment and tracking in science is inconsistent. In a minority of schools, leaders have established clear systems to assess and track pupils' scientific progress, which helps teachers identify what pupils have learnt and supports leaders in evaluating curriculum impact. In these schools, assessment is linked closely to progression frameworks and focuses on pupils' developing knowledge and skills rather than solely on task completion. Assessment is strongest where expectations for progression and misconceptions are shared across phases, reducing repetition and strengthening continuity at transition. However, in a majority of schools, assessment practices are less well-defined which limits teachers' ability to identify what pupils understand and where misconception remain. In a minority of schools, leaders and staff report uncertainty about what constitutes progress in science, particularly within enquiry-based learning, resulting in assessment that focuses more on participation than on conceptual understanding. Where assessment and monitoring are weakest, leaders find it difficult to identify gaps in pupils' learning or to assure themselves that curriculum plans are securing consistent progress across year groups. Overall, while teachers routinely use questioning and other in-lesson strategies to check pupils' understanding, in a minority of schools they do not use coherent approaches to monitor pupils' scientific progress or to use this information effectively to refine the curriculum.

Teaching science in the primary phase

In a majority of schools, science teaching is practical, experiential and engaging, with pupils responding positively to hands-on investigations, real-life contexts and effective lesson introductions that engage pupils. These approaches successfully capture pupils' interest and contribute to strong enjoyment of science, particularly where pupils are encouraged to predict, test ideas and work collaboratively. However, in a majority of primary schools, teaching places too much emphasis on completing activities or following enquiry routines, with insufficient focus on securing the underlying scientific concepts. In these lessons, pupils are often able to describe what they did but are less confident in explaining their results or which scientific ideas they were learning. This reflects findings from the Education Endowment Foundation (2023), which emphasise the importance of combining practical enquiry with explicit teaching of scientific concepts and vocabulary in order to develop secure scientific understanding.

In a majority of cases, teachers' questioning does not consistently probe pupils' thinking deeply enough. They do not always identify or address misconceptions systematically. In these cases, engagement is prioritised over learning, limiting the development of secure conceptual understanding.

Where pupils make greatest progress, teachers pause practical work to model ideas, reinforce vocabulary and revisit key concepts, so that practical activity reinforces learning rather than replacing it.

In a majority of schools, teachers place appropriate emphasis on the explicit teaching of scientific vocabulary, which supports pupils in developing more precise understanding and communication of scientific ideas. Teachers routinely introduce subject-specific terms, such as stability, rate of descent, variables and insulation, and model their accurate use through discussion, questioning and explanation. In the strongest practice, vocabulary is revisited deliberately during lessons and pupils are encouraged to use it in discussion and written work. This helps pupils to explain their thinking more clearly and strengthens conceptual understanding. However, in a minority of schools, vocabulary teaching is less systematic. In these schools, teachers introduce key terms but do not reinforce them sufficiently, which leads to pupils using imprecise or everyday language when explaining scientific processes. Too often, teachers miss opportunities to correct misconceptions and refine pupils' use of terminology, limiting the depth of pupils' scientific explanations.

Hands-On, First-Hand, Contextual Science

At **Penyrheol Primary School**, pupils' experiences of science are rooted in hands-on, first-hand and highly contextual learning. Leaders and teachers prioritise practical engagement, ensuring that pupils learn science through direct interaction with real phenomena rather than solely through abstract activities. This approach helps pupils to develop secure understanding and strong positive attitudes towards science from an early age.

Teachers carefully plan opportunities for pupils to investigate scientific concepts within meaningful contexts that reflect the school's locality and pupils' lived experiences. For example, pupils study environmental science through work linked to the River Loughor, including visits to the river estuary to investigate pollution levels and consider the impact of human activity. These experiences enable pupils to apply scientific enquiry skills purposefully, such as identifying variables, collecting data and drawing conclusions using appropriate scientific vocabulary.

Across the school, staff balance explicit teaching with enquiry-based learning. Teachers ensure pupils are taught key knowledge and skills directly before applying them through practical investigations. Pupils regularly engage in activities such as testing materials, filtering water, measuring heart rates and building simple structures, which deepen understanding through doing. The school also makes strong use of outdoor learning, both on-site and further afield, to enhance pupils' scientific experiences.

As a result, pupils speak enthusiastically about science, show confidence in practical investigations and understand how their learning builds over time. This coherent, experience-led approach supports strong progress and sustained engagement in science across the school.

Developing pupils' literacy, numeracy and digital skills

In many schools, science lessons provide opportunities for pupils to develop literacy, numeracy and digital skills alongside their scientific learning. Teachers plan activities that require pupils to record observations, explain ideas, and discuss findings, which supports the development of subject-specific language and wider literacy skills. Numeracy is often applied through measuring, graphing, calculating averages or interpreting data, helping pupils to use mathematical skills in relevant contexts. In a few schools, pupils make appropriate use of digital tools, such as spreadsheets, simulations or data-logging software, to collect, analyse and present information during investigations. Where these approaches are well integrated, pupils understand the relevance of literacy, numeracy and digital skills and apply them confidently to support scientific enquiry. However, in a minority of schools, teachers over-scaffold or overly prescribe how pupils apply cross-curricular skills, which limits pupils' independence and reduces opportunities for deeper reasoning. Overall, when science is used as a context for applying literacy, numeracy and digital skills purposefully, it enhances pupils' engagement and strengthens their ability to communicate, analyse and evaluate scientific ideas. However, too often developing pupils' cross-curricular skills is prioritised, resulting in weaker emphasis on pupils' subject knowledge and conceptual understanding.

Attitudes towards learning science

In a majority of schools, pupils demonstrate positive attitudes towards science, which contributes well to their engagement and willingness to participate actively in lessons. These attitudes are developed most effectively where teaching is practical, experiential and rooted in meaningful contexts that allow pupils to investigate, test ideas and solve problems for themselves. Pupils value opportunities to work collaboratively, make predictions and learn through first-hand experiences, and many describe science as enjoyable, exciting and different from other subjects. In schools where teachers use precise vocabulary, encourage discussion and create a supportive environment in which mistakes are viewed as part of learning, pupils show increased confidence in sharing ideas and engaging with challenging concepts. This positive disposition supports pupils' curiosity and resilience, helping them to persevere with challenging tasks and to reflect thoughtfully on their learning. Where attitudes towards science are strongest, pupils recall learning vividly, talk enthusiastically about investigations and show growing confidence in applying their knowledge and skills. Overall, positive attitudes play an important role in sustaining pupils' engagement in science and in supporting the development of independent, motivated learners who are more willing to explore and explain scientific ideas.

Bringing science to life through meaningful community and industry links

At **Castle Park Primary School**, leaders have placed strong emphasis on using community and industry links to make science purposeful, engaging and aspirational for pupils. These partnerships are used strategically to help pupils understand the real-world relevance of science and to raise awareness of future career pathways.

Teachers regularly plan science learning around authentic experiences supported by external visitors and local businesses. For example, as part of a Victorian history topic, pupils worked with a representative from Pfizer to explore the development of vaccines. This real-world link deepened pupils' understanding of scientific concepts while also introducing them to careers in science and medicine. Pupils extended this learning further by entering a vaccine-related competition judged by an industry professional, giving their work a genuine audience and purpose.

Other partnerships also enhance pupils' scientific experiences. A project with a local musician supported pupils' learning about sound, pitch and vibration through the design and creation of musical instruments. Similarly, a unit linked to 'Charlie and the Chocolate Factory' was enriched through collaboration with a local cake company, helping pupils explore changes of state in food science before designing, marketing and presenting their own products to parents.

These experiences are underpinned by the school's vision to provide experiences for pupils to be happy, resilient and confident learners. By embedding science within meaningful community and industry contexts, the school enables pupils to see how scientific knowledge applies beyond the classroom. As a result, pupils speak enthusiastically about science, understand its relevance to everyday life, and develop early aspirations linked to STEM careers.

Practices that support understanding and engagement

In a majority of schools, teachers use modelling effectively to support pupils' understanding of scientific concepts and processes. Where practice is strongest, teachers break learning into manageable steps, demonstrate methods clearly and think aloud to make scientific reasoning explicit. This includes modelling how to plan investigations, identify variables, record results or use scientific vocabulary accurately.

In these schools, modelling helps pupils understand what high-quality scientific thinking looks like and supports them to apply knowledge and skills more independently. In a minority of schools, modelling is less consistent and focuses more on completing tasks than on explaining the underlying science. In these cases, pupils are clear about what to do but less secure in understanding why outcomes occur or how ideas connect. Where teachers combine clear modelling with purposeful questioning and opportunities for pupils to practise and explain their thinking, pupils develop greater confidence and conceptual clarity. Overall, effective modelling plays an important role in bridging practical activity and scientific understanding.

In a minority of primary schools, teachers use a range of assessment methods effectively to identify pupils' understanding and adapt teaching in real time. In these schools, teachers use purposeful questioning, close observation and structured discussions to check pupils' thinking, identify misconceptions and adjust tasks or explanations accordingly. This responsive approach helps pupils clarify ideas as they work and supports more secure conceptual understanding. However, in a majority of schools, assessment during lessons is less well developed and focuses more on pupils' engagement or task completion than on probing scientific understanding. In these cases, questioning is too general or closed to reveal pupils' reasoning, and misconceptions are not always identified or addressed promptly. Where assessment is weakest, pupils complete practical activities successfully but remain unsure about the scientific principles underpinning their work. Overall, while formative assessment is evident in most classrooms, in a majority of cases, it does not consistently inform teaching or support deeper scientific understanding.

Bringing science to life through meaningful community and industry links

At **Ysgol Manod Primary School**, science teaching is firmly rooted in practical experience, giving pupils regular opportunities to investigate, experiment and solve problems in meaningful contexts. Teachers have moved away from traditional, worksheet-led approaches and instead prioritise active learning that promotes independence, curiosity and resilience.

Science is taught through purposeful themes, such as Africa, where pupils work in small groups to tackle real-life problems. For example, pupils investigate how to filter dirty water effectively, applying scientific thinking to a global issue. During these sessions, pupils are encouraged to make predictions, test ideas, refine their methods and explain their reasoning. Teachers use well-planned questioning to challenge pupils' thinking and to address misconceptions as they arise.

A strong feature of practice is the celebration of 'camgymeriadau campus' or 'brilliant mistakes'. When experiments do not work as expected, teachers use these moments as valuable learning opportunities, helping pupils to understand why outcomes occurred and how approaches could be improved. This creates a safe, non-threatening learning environment where pupils feel confident to take risks, discuss ideas and learn from trial and error.

Practical science is embedded across the curriculum through learning areas and hands-on activities, enabling pupils to apply their knowledge and skills independently. Teachers felt that, as a result, pupils were highly engaged, enjoyed learning science, and developed strong problem-solving skills alongside secure scientific understanding through first-hand experience.

Subject knowledge, misconception and independence

Teacher subject knowledge varies across the schools visited and influences the quality of science teaching. Where subject knowledge is secure, teachers identify and address misconceptions, use probing questioning and adapt teaching responsively to deepen pupils' understanding. However, in a majority of schools, misconceptions are not consistently anticipated or challenged. Although teachers often build on prior learning within lessons, they do not plan systematically for common conceptual difficulties. As a result, pupils may complete activities successfully but retain partial or inaccurate understanding, limiting the depth, coherence and progression of their scientific reasoning over time.

Using progression maps to anticipate and address misconceptions

Bishopston Primary School has developed a carefully structured science progression map aligned closely with the statements of what matters, which supports teachers in planning learning coherently across year groups. The progression map helps staff identify how scientific knowledge, skills and understanding should build over time and provides a shared reference point for anticipating where pupils may encounter conceptual difficulty. Teachers use the map to plan discrete teaching of key scientific knowledge before pupils engage in investigations, reducing the likelihood of misconceptions arising from task-led learning. Collaboration with the local secondary school has further strengthened this work, particularly through agreed expectations for key scientific vocabulary and skills prior to Year 7. During lessons, teachers routinely activate prior learning and use questioning and modelling to identify and address misconceptions as they arise. This combination of structured long-term planning and responsive teaching supports pupils to develop more secure and connected scientific understanding as they progress through the school.

Evaluating and sustaining progression over time

Approaches to monitoring pupils' progress in science vary across the schools visited and do not consistently provide leaders with a secure understanding of how pupils' scientific knowledge develops over time. In a minority of schools, leaders use evidence from pupils' work and discussions with learners to monitor how key concepts are revisited and extended across year groups. This enables leaders to identify whether learning builds cumulatively and to recognise where pupils' understanding deepens as intended. However, in a majority of primary schools, monitoring does not focus sharply enough on pupils' conceptual development. In these schools, leaders find it more difficult to identify uneven progression or gaps in understanding, particularly where pupils revisit similar topics or investigations. As a result, leaders do not always have a clear picture of how effectively the curriculum supports pupils to develop increasingly secure and connected scientific understanding over time. Where leaders prioritise professional learning, shared planning and clear guidance on science content and progression, curriculum plans are more coherent and support greater consistency in the development of pupils' understanding of science.

The science curriculum in the secondary phase

Curriculum design and progression in scientific knowledge

In a majority of secondary schools, leaders have established structured plans for the delivery of science that place appropriate emphasis on the development of pupils' core scientific knowledge across biology, chemistry and physics. In these schools, curriculum structures are well defined and organised through disciplinary models or carefully designed approaches that retain a clear focus on subject content. In the strongest practice, leaders sequence scientific knowledge carefully across Year 7 to Year 9 and make expectations for progression explicit, enabling pupils to revisit and deepen understanding as scientific ideas become increasingly complex. This aligns with research highlighting the importance of carefully sequenced curricula that support pupils to build and connect scientific knowledge over time (Ofsted, 2021). However, in a minority of secondary schools, curriculum planning does not secure this level of clarity. In these schools, planning often emphasises coverage of content within individual units but is less effective in showing how pupils' scientific knowledge is intended to develop over time. This is particularly evident in some thematic or hybrid models, where engaging contexts are used but the underlying scientific concepts are not always revisited at increasing levels of challenge. Evidence from all-age schools indicates that knowledge progression is most secure where secondary teachers have a clear understanding of pupils' prior learning from the primary phase, reducing unnecessary repetition and supporting continuity at transition.

In a majority of secondary schools, science curricula are organised around content-led modules reflecting traditional disciplinary structures in biology, chemistry and physics. While this approach supports clarity, coverage and consistency, particularly in preparing pupils for examination requirements, it often reflects practice in Year 10 and Year 11, where curriculum design is influenced by qualification requirements. As a result, it may not fully reflect the broader aims of Curriculum for Wales. However, in a minority of schools, reliance on content-led models limits opportunities for pupils to make connections across topics or apply their knowledge in unfamiliar contexts. Where classes are taught by different teachers for biology, chemistry and physics, continuity can be reduced and it can be more difficult to build learning cumulatively over time. However, these models often allow teachers to draw on stronger subject expertise which can support more accurate explanations and secure delivery of scientific content. The effectiveness of this approach depends on how well curriculum planning and communication between teachers ensure coherence and progression for pupils.

Application of science through real-world and recent developments

In a majority of secondary schools, curriculum planning includes opportunities for pupils to engage with real-world and contemporary scientific contexts that help them understand science as relevant and connected to society. In these schools, issues such as climate change, sustainability, health, energy use, genetics and environmental impact are incorporated within schemes of learning and linked to core scientific concepts. Stronger practice is evident where these contexts are embedded within curriculum sequences and revisited across Years 7 to 9, enabling pupils to apply and deepen their scientific knowledge in increasingly complex and familiar situations. While many schools recognise the value of real-world and contemporary science, the extent to which these contexts are embedded consistently within curriculum planning varies across the sample.

In many secondary schools, leaders plan a range of enrichment and applied science opportunities that broaden pupils' experiences beyond the taught curriculum. These opportunities include STEM challenges, science clubs, project-based learning, external visits and links with universities, employers or local industry. In stronger practice, enrichment activities are connected closely to curriculum content, enabling pupils to apply their scientific knowledge and skills to real-world problems, such as investigating sustainability, forensic science or engineering challenges. However, across the wider sample, provision is uneven. In around half of secondary schools, enrichment activities are optional or episodic and are not always aligned closely with curriculum sequencing. In these schools, applied science opportunities tend to sit alongside, rather than within, the planned curriculum, and their impact on pupils' learning is less clear. In a minority of schools, enrichment is limited largely to examination pathways or end-of-year projects, restricting access for some pupils.

Using real-world experiences and enrichment to raise pupils' aspirations

Leaders at Ysgol y Moelwyn have placed a strong emphasis on using real-world experiences to make science meaningful and to raise pupils' aspirations. These experiences are not treated as one-off events but are planned carefully as an integral part of the science curriculum and linked closely to the school's 'big question' approach.

In Years 7 to 9, curriculum units are designed around contemporary and locally relevant issues such as energy use, sustainability and materials. Leaders have deliberately built in opportunities for pupils to apply their learning beyond the classroom through visits, projects and partnerships with local employers, industries and organisations. These experiences help pupils to see the relevance of science to everyday life and to the local area, strengthening their understanding of why scientific knowledge matters.

In addition, leaders have developed strong links with universities and external organisations to provide more aspirational enrichment. Pupils benefit from mentoring schemes, structured project-based learning and visits that expose them to a wide range of science-related careers and pathways, including routes into further and higher education. These opportunities enable pupils to undertake extended, independent enquiries, develop wider skills and gain recognition for their achievements. This work has been particularly effective in broadening pupils' horizons and raising aspirations, including for those from less advantaged backgrounds.

As a result, pupils show increased interest and engagement in science and have a clearer understanding of how science connects to future study and employment. The sustained and purposeful use of real-world and aspirational experiences has helped to raise the profile of science within the school and supports pupils to view science as both relevant and achievable.

Teaching in the secondary phase

Within the Curriculum for Wales, effective teaching supports pupils' progression in their understanding of scientific concepts, however, variability remains in how teachers interpret and apply guidance on progression and assessment. In most of the secondary schools visited, teachers demonstrate secure subject knowledge and many use purposeful modelling to support pupils' understanding of complex scientific concepts. Where practice is strongest, teachers explain ideas clearly and accurately and break learning into manageable steps. They model both scientific thinking and procedures explicitly, helping pupils understand how scientific ideas are developed and tested through enquiry and evidence. Teachers use annotated diagrams, worked examples, practical demonstrations and carefully sequenced explanations to reduce cognitive load and build understanding progressively. In the strongest lessons, modelling is closely aligned with questioning, enabling teachers to probe pupils' thinking, identify misconceptions and adapt teaching in real time. Pupils respond positively to this approach, showing confidence in using scientific terminology and explaining their reasoning. However, in around half of schools, although modelling is accurate and well-structured, it is overly directed, which limits opportunities for pupils to think independently or apply their learning in unfamiliar contexts. Strong subject knowledge underpins effective modelling in lessons. Where teachers use this knowledge to explain key ideas clearly and address misconceptions, pupils develop secure conceptual understanding and make strong progress in science.

In around half of secondary schools, teaching in science places a clear emphasis on helping pupils understand underlying concepts and relationships rather than memorising isolated facts. In these schools, teachers design learning sequences that encourage pupils to make connections across topics, revisit key ideas over time and explain scientific processes using evidence and reasoning. Pupils are routinely asked to justify answers, compare explanations and reflect on how new learning builds on what they already know, which supports deeper understanding and transfer of knowledge to unfamiliar contexts. This reflects wider evidence on effective science teaching, which highlights the importance of developing pupils' conceptual understanding and addressing misconceptions explicitly (Education Endowment Foundation, 2018). However, in the remainder, teachers do not develop pupils' conceptual understanding as securely. Teaching in these schools is often driven by curriculum coverage, resulting in lessons that prioritise pace and completion over depth. Pupils in these schools can recall information accurately but are less confident in applying ideas, explaining relationships or reasoning scientifically.

In a majority of secondary schools, teachers use questioning productively to check pupils' understanding and to move learning forward during lessons. In the strongest practice, questions are planned and sequenced to encourage pupils to articulate their thinking, justify responses and draw on prior learning, rather than simply recall information. Teachers use a range of strategies, such as follow-up questions, targeted prompts and structured discussion, to help pupils refine answers and learn from each other's ideas. This supports pupils in developing confidence to explain scientific ideas clearly and to engage thoughtfully with challenging concepts. However, in a minority of schools, questioning is less effective in deepening understanding. In these lessons, teachers rely more heavily on closed or low-level questions that confirm correct answers but do not expose misconceptions or extend pupils' reasoning. As a result, some pupils remain passive contributors and misconceptions persist unnoticed. While questioning is a routine feature of science lessons in many schools, variability in its depth and purpose affects how well it supports pupils in developing secure and extended scientific understanding.

In a majority of secondary schools, teachers use assessment practices effectively to support pupils' progress in science. In these schools, assessment is integrated into learning and used to identify gaps in understanding and help pupils reflect on their progress. Teachers make purposeful use of short diagnostic activities, retrieval tasks and focused feedback to help pupils consolidate learning and improve the quality of their responses over time. However, in a minority of schools, assessment is less closely aligned with learning and is used primarily to record attainment or check task completion. In these cases, assessment information is not always used consistently to adapt teaching or address misconceptions, and pupils have limited opportunities to act meaningfully on feedback. As a result, progress is uneven and some pupils repeat similar errors over time. Overall, where assessment is used deliberately to inform teaching and support reflection, it contributes positively to pupils' progress, but inconsistency in practice limits its impact in a minority of schools.

In a majority of secondary schools, teachers use a range of teaching approaches that support pupils' engagement in science lessons. These include practical activities, collaborative discussion, use of real-life and contemporary contexts, and varied tasks that encourage active participation. Pupils respond positively where lessons provide opportunities to apply learning, work with peers and explore scientific ideas in meaningful ways, which helps sustain interest and motivation. However, in a minority of schools, engagement is less consistent, especially in examination classes where teaching is more tightly focused on coverage and written outcomes. In these lessons, approaches are more repetitive and provide fewer opportunities for pupils to explore ideas independently or apply their learning, which reduces enthusiasm and limits sustained engagement. While engaging approaches are evident in a majority of schools, variation in how these are balanced with curriculum demands affects the extent to which pupils remain motivated and actively involved in their science learning.

Over-scaffolding in science lessons is evident in around half of secondary schools, this limits pupils' independence and reduces opportunities for them to think and reason for themselves. In these lessons, tasks are often tightly structured, with step-by-step instructions, pre-completed models or extensive teacher guidance that leaves little space for pupils to make decisions, test ideas or explain their thinking. While this approach supports task completion, it can mask gaps in understanding and restrict pupils' ability to apply knowledge in unfamiliar situations. In examination classes, over-scaffolding is particularly evident, as an increased emphasis on tightly guided responses often reduces opportunities for pupils to explore ideas, think independently and develop deeper understanding. As a result, some pupils become reliant on teacher input and lack confidence when expected to work independently or justify their ideas. Where independence is underdeveloped, pupils are less able to transfer learning across topics or engage in sustained reasoning. Overall, although scaffolding supports access for many pupils, excessive reliance on it in around half of schools constrains independence and limits deeper engagement with scientific thinking.

Aligning whole-school pedagogy framework with subject expertise

At **Bishop of Llandaff School**, leaders have established a clear and coherent whole-school pedagogical framework that focuses sharply on the impact of teaching on pupils' learning. A small number of shared principles provide consistency and clarity across the school, while allowing departments flexibility in how these are applied within their subjects.

In science, teachers use this framework effectively to plan learning in logical sequences, anticipate common misconceptions and adapt teaching in response to pupils' understanding. Collaborative planning plays an important role in this work. Teachers contribute collectively to detailed schemes of learning, which support coherence and progression across year groups and help develop a shared understanding of effective practice.

In lessons, teachers apply the agreed pedagogical principles with confidence. Questioning, modelling and feedback are used purposefully to deepen pupils' understanding and promote accurate use of scientific language. Pupils respond well to this approach, showing high levels of engagement and making strong progress over time.

This alignment between whole-school pedagogy and subject practice has created a professional culture where expectations are clear, collaboration is valued and teachers are supported to refine their practice in ways that meet the specific demands of their subject.

In around half of secondary schools, examination pressures in Year 10 and Year 11 narrows the range and depth of science teaching. In these schools, lessons often focus strongly on covering specification content, practising examination questions and securing marks, which reduces opportunities for pupils to explore ideas in depth or apply their learning in varied contexts. Teaching becomes more tightly directed towards written outcomes and examination technique, and pupils experience fewer opportunities for extended practical work, discussion or exploration of contemporary scientific issues. However, in the remainder of schools, teachers maintain pupils' interest through imaginative planning and enthusiastic delivery, even within the constraints of examination requirements. Where this occurs, pupils remain more engaged and are better able to sustain their interest in science. Nevertheless, in many schools, pupils report that science in Year 10 and Year 11 is less engaging than in the preceding years and perceive lessons as being primarily focused on examination preparation. While this approach supports familiarity with examination demands, it can limit opportunities for pupils to deepen conceptual understanding and develop independence in their thinking.

Scientific skills and cross-curricular skills

In around half of secondary schools, leaders plan effectively for the progressive development of pupils' scientific skills, including practical techniques, enquiry processes and analytical skills. In these schools, curriculum plans identify key skills and revisit them across Year 7 to Year 9, enabling pupils to build confidence and competence as tasks become more demanding. Stronger practice is evident where departments map investigative skills clearly and ensure pupils apply them in a range of contexts, supporting continuity and reducing repetition. However, in the remainder of secondary schools, planning for the progression of scientific skills is less well developed than that for scientific knowledge. In these settings, practical activities are included regularly, but curriculum documentation does not always show how pupils' skills are intended to develop over time. As a result, pupils often repeat similar types of investigations without a clear increase in challenge or sophistication. Evidence from schools where collaboration is most effective shows that skills progression is strongest where expectations are aligned across phases and secondary teachers build directly on pupils' prior experiences.

Developing progression in literacy and numeracy skills through the science curriculum

Leaders at **The Maelor School** have planned the science curriculum carefully to support the progressive development of pupils' literacy and numeracy skills from Year 7 to Year 11. These skills are not taught in isolation but are embedded purposefully within scientific contexts and revisited with increasing levels of challenge over time.

In numeracy, leaders have identified clear progression in pupils' use and interpretation of data. Pupils begin by plotting line graphs using given scales before progressing to selecting appropriate scales independently and working with more complex datasets. Over time, pupils develop greater confidence in interpreting a range of graphical representations, culminating in the analysis of graphs that present multiple data sets and require more sophisticated reasoning.

Literacy development is also planned systematically across topics. Teachers provide pupils with increasingly challenging scientific texts and design reading tasks that move from basic retrieval skills, such as skimming and scanning, towards more demanding activities, including summarising and evaluating information from multiple sources. Extended writing tasks are embedded across the curriculum and are scaffolded appropriately in the early years. As pupils move through the school, scaffolding is reduced and pupils are expected to produce more extended and analytical responses, drawing on explanation, analysis and synthesis.

As a result of this coherent approach, pupils develop their literacy and numeracy skills securely within meaningful scientific contexts. This supports stronger progress in science and helps pupils to apply these skills with increasing independence and confidence.

In most secondary schools, leaders recognise the importance of developing literacy, numeracy and cross-curricular skills through science, and curriculum plans frequently reference these areas. In many schools, pupils practise skills such as graph work, data interpretation and the use of scientific vocabulary within lessons. However, in a majority of schools, this planning does not translate into sufficiently deliberate or meaningful opportunities for pupils to apply these skills to deepen scientific understanding. Instead, cross-curricular skills are often addressed through routine or procedural tasks, with limited emphasis on reasoning or application. Stronger practice is evident in a minority of schools, where literacy and numeracy are mapped explicitly across Years 7 to 9 and revisited progressively alongside scientific learning.

In the most effective lessons, teachers use science as a meaningful context to develop pupils' reading, writing and oracy skills. Pupils read scientific texts with increasing confidence, interpret evidence and data accurately, and use appropriate subject terminology when explaining their ideas. Teachers support pupils to articulate their thinking clearly and justify conclusions using evidence, helping them to move beyond brief or formulaic responses. Where this practice is less well developed, pupils complete written or practical tasks without being required to explain their reasoning in depth, limiting opportunities to strengthen both their literacy skills and their scientific understanding.

When numeracy is integrated effectively into science lessons, pupils use data and measurement to deepen their understanding of scientific ideas. They construct and interpret graphs accurately, apply calculations and formulae appropriately, and recognise patterns and anomalies in results. This enables them to draw conclusions that are supported by numerical evidence rather than relying on description alone. However, in weaker practice, numerical work is treated as a procedural exercise, focused on completing calculations or plotting graphs without sufficient attention to interpretation. As a result, pupils handle data competently but do not always understand how it informs scientific explanation.

Progressive development of pupils' scientific writing

Leaders and teachers at **Llanwern High School** have placed a strong and deliberate focus on the progressive development of pupils' scientific writing. This work is underpinned by a whole-school emphasis on literacy, which the science department has adapted effectively to meet the specific demands of scientific communication.

Across all year groups, teachers plan regular and purposeful opportunities for pupils to write scientifically, moving from structured sentence-level responses towards more extended and independent explanations. Teachers use consistent success criteria, shared writing frames and approaches that support pupils to organise their thinking and communicate scientific ideas clearly and accurately. This supports pupils to develop increasing confidence in using subject-specific vocabulary and explaining processes, relationships and concepts precisely. Leaders have ensured that expectations for scientific writing are clear and progressive. Pupils revisit and refine key writing skills across different contexts, helping them to consolidate learning and apply it more independently over time.

Staffing and curriculum continuity

In a minority of secondary schools, curriculum delivery is affected by the use of non-specialist teachers and split class teaching arrangements, particularly in Years 7 to 9. In these schools, staffing structures mean that teachers deliver science outside their subject specialism or share responsibility for teaching the same class, which can lead to variation in pupils' experiences. In many schools, departmental leaders provide effective support by designing curriculum plans that promote consistency, including shared schemes of learning, centrally produced resources, and common assessments to promote consistency. However, where teachers have not received sufficient subject-specific professional learning or ongoing departmental support, pupils' experiences are less consistent, particularly in relation to the accuracy and depth of scientific explanations, use of subject-specific language and the development of more abstract concepts, especially in physics and chemistry. Although non-specialist and split-class teaching is managed effectively in many contexts, it remains a feature in a minority of schools that contributes to variability in curriculum delivery and pupils' scientific experiences.

Collaboration and continuity

In a minority of secondary schools, collaboration with primary schools, clusters or all-age partners strengthens curriculum planning and supports greater coherence at transition. In these schools, joint planning activities, shared professional dialogue and agreed curriculum expectations help secondary departments understand pupils' prior experiences and plan learning that builds on existing knowledge and skills. Collaboration is most effective where expectations for progression are shared across phases, resulting in clearer sequencing and reduced repetition in Year 7 to Year 9. Where collaboration with primary partners is limited or inconsistent, teachers have a weak understanding of pupils' prior learning in science on entry to Year 7. In these schools, curriculum planning often assumes variable starting points and treats Year 7 as a fresh beginning rather than a continuation of prior learning. As a result, pupils' experiences at transition vary, and opportunities to build directly on existing knowledge and understanding are not always evident. While collaboration enhances curriculum coherence, inconsistency in cluster working and limited insight into prior learning remain common features across the secondary phase.

Developing a shared understanding of progression in science across the cluster

Leaders at Cefn Hengoed Community School have developed a strong and purposeful approach to supporting pupils' transition in science from the primary to the secondary phase. Drawing on close collaboration with cluster primary schools, science leaders worked together to develop shared progression step portfolios at Progression Steps 1 to 3. These portfolios exemplify pupils' scientific knowledge, skills and understanding and provide a common reference point for teachers across the cluster.

This collaborative work has strengthened teachers shared understanding of progression in science and reduced repetition when pupils move into Year 7. Secondary teachers use the portfolios to identify pupils' prior learning, enabling them to plan learning that builds more securely on pupils' earlier experiences. Regular cluster meetings, led by the secondary science department, support professional dialogue about curriculum expectations, pedagogy and assessment in science.

As a result, transition arrangements are more coherent and purposeful. Pupils benefit from greater continuity in their learning, while teachers across the cluster have increased confidence in their understanding of progression in science and expectations at each progression step which helps ensure continuity and progression across phases.

Assessment of knowledge and progression

Approaches to assessment in secondary science vary across the schools visited and reflect differences in how well leaders' curriculum plans are reflected in classroom practice. In many secondary schools, teachers assess pupils' scientific knowledge regularly through end-of-unit tests, written tasks and examination-style questions. These discrete assessments provide a clear indication of pupils' understanding and recall of key facts, terminology and concepts, and support consistency across classes. However, in a minority of schools, assessment information is not used effectively to evaluate how pupils' knowledge builds over time. While assessments appropriately focus on specific topics, departments do not always consider how well pupils are connecting ideas across units or applying their knowledge in different scientific contexts.

Insufficient clarity in how progression is interpreted within the Science and Technology Area of Learning and Experience can lead to uncertainty about how pupils' understanding of scientific concepts and skills should deepen over time. While the Curriculum for Wales requires schools to develop coherent assessment approaches to support progression, many teachers report challenges in translating this guidance into practice. As a result, assessment does not always provide a clear and consistent picture of pupils' developing understanding across Year 7 to Year 9, leading to variability in practice.

Progression in the secondary phase

Approaches to anticipating and identifying misconceptions during science lessons vary across the schools visited. In around half of schools, teachers identify misconceptions effectively during lessons through well-chosen questioning, retrieval activities and formative assessment strategies such as mini whiteboards or short diagnostic tasks. In these classrooms, teachers adapt explanations, revisit key ideas or use alternative examples to clarify pupils' understanding before misconceptions become embedded. However, in too many schools, identification of misconceptions relies largely on teachers' in-the-moment judgement rather than on systematic planning. As a result, misconceptions are addressed inconsistently and may be missed, particularly during practical or task-focused activities where pupils appear engaged but have only partial understanding.

The strategic anticipation of misconceptions through curriculum and assessment planning is less well developed. In a minority of schools, leaders have embedded anticipation of common misconceptions into schemes of learning, curriculum plans or assessment points, enabling teachers to plan explanations, examples and checks for understanding in advance. In these schools, shared understanding of likely conceptual pitfalls supports greater consistency across classes and reduces variation in pupils' learning experiences. However, in a majority of schools, misconceptions are not identified systematically within medium- or long-term planning, and responsibility for addressing them rests largely with individual teachers. This contributes to variation in how effectively misconceptions are addressed across topics and year groups.

Planning a curriculum focussed on progression and purposeful assessment

Leaders at **Cardiff High School** have developed a carefully structured science curriculum in which progression and assessment are considered together from the outset. The curriculum is underpinned by clear principles of breadth, value and coherence, with leaders viewing the curriculum itself as the main vehicle for securing progression over time rather than relying on isolated assessment events.

In Year 7 to Year 9, topic sequences are planned collaboratively and build systematically on prior learning. Leaders have identified key concepts and set out clear learning intentions for each topic, which help teachers pitch learning appropriately and ensure that expectations increase in complexity over time. Medium-term plans also highlight likely misconceptions and provide guidance on how these can be identified and addressed through teaching.

Assessment is integrated closely with curriculum planning and is not treated as an add-on. Leaders have built in regular opportunities for assessment for learning, alongside more considered assessment of learning, which are aligned directly to the intended outcomes of each topic. This approach supports teachers to check understanding routinely, adapt teaching where needed and evaluate pupils' progress against clearly defined success criteria.

As a result, teachers have a shared understanding of progression in science and use assessment information purposefully to support pupils' learning. This coherent approach to curriculum design, progression and assessment has helped to secure consistency in expectations and support strong progress for pupils over time.

Leading and improving

Leading and improving in the primary phase

Strategic leadership and resourcing for science

Across the primary schools visited, leaders generally articulate a clear and positive vision for science that emphasises relevance, aspiration and real-world application. In a majority of schools, science is appropriately prioritised within whole-school improvement plans, and leaders ensure it maintains a visible profile through suitable curriculum time, targeted resourcing and purposeful enrichment. In the strongest examples, leaders draw effectively on partnerships with industry, community organisations and other schools within their cluster schools to strengthen the strategic direction and to connect science learning to authentic contexts and future pathways.

Overall, leadership capacity to support science is too variable. In a majority of schools, access to subject-specific professional learning in science is limited, and this constrains staff confidence in developing and sustaining a coherent strategic direction for the subject. As a result, the extent to which leaders are able to build collective expertise and shared understanding of effective science practice differs between schools. Improvement relies too heavily on the commitment of individual teachers rather than on leaders ensuring suitable professional learning and support for all staff.

A majority of the primary schools visited allocate an appropriate amount of curriculum time and resources to the teaching of science. In these schools, leaders ensure that science features regularly in timetables and provide flexibility to allow extended practical investigations that supports deeper learning. A few schools have invested purposefully in resources, including practical equipment, digital tools and outdoor learning facilities, which enable pupils to engage in hands-on scientific enquiry and apply their knowledge in meaningful contexts. In a few schools, leaders make strategic use of external funding or partnerships to enhance resourcing and to broaden pupils' experiences through enrichment activities and specialist input. However, in a minority of schools, the allocation of curriculum time for science is less consistent. In these schools, science is more likely to be taught intermittently or predominantly through thematic work, which can result in uneven exposure to scientific learning across the year. Where time allocation is less secure, pupils' experiences of science depend heavily on topic selection rather than on planned purposeful opportunities, and access to practical resources is not always matched by regular opportunities to use them.

Quality assurance and evaluation

Approaches to the monitoring and evaluation of science teaching vary across the schools visited. In a minority of schools, leaders have established systematic processes to evaluate the quality of science teaching and its impact on pupils' learning, using a combination of lesson observation, scrutiny of pupils' work and discussion with pupils. In these schools, leaders have a clear understanding of strengths and areas that require further development in science pedagogy. However, in a majority of schools, monitoring of science teaching is less structured and is often subsumed within broader whole-school processes rather than focused specifically on science. In these cases, leaders rely on informal feedback or general observations, which limits their insight into how effectively teaching approaches support conceptual understanding across year groups. Where monitoring is weakest, leaders do not identify inconsistencies in how science is taught or in pupils' learning. As a result, they have a less secure understanding of how well pupils develop their scientific knowledge and understanding over time. Overall, the extent and rigour of monitoring and evaluation influence how clearly schools understand the quality and consistency of science teaching across the primary phase.

Collaboration, partnerships and continuity

Leaders in a majority of the schools plan purposeful opportunities to support and strengthen science provision. For example, they establish and sustain relationships with local businesses, industry partners, STEM professionals and community organisations to enrich pupils' experiences and to raise the profile of science within the curriculum. These partnerships are often used strategically to support curriculum priorities, such as providing authentic contexts for learning, increasing pupils' awareness of science-related careers and strengthening links between scientific concepts and real-world applications. In a majority of schools, leaders also draw on cluster and secondary partnerships to support aspects of curriculum coherence and shared ambition, particularly where science forms part of wider Area or cluster work. However, the extent to which leaders use partnerships as part of a coherent improvement strategy varies. In a minority of schools, partnerships are more opportunistic and reliant on individual contacts, rather than being embedded within a clear leadership approach to developing science, resulting in variability in the impact and sustainability of this work across the school.

Across the primary schools visited, a majority of leaders engage purposefully in collaborative practice through cluster networks to support the development of science. In these schools, leaders work with partner schools to share planning approaches, agree aspects of progression and provide opportunities for joint professional dialogue. Where collaboration is strongest, leaders use cluster structures to build shared expectations for science learning and to support greater continuity as pupils move between phases. However, the quality and consistency of collaboration varies across the sample. In a minority of schools, science is not prioritised within cluster arrangements, and collaborative activity focuses more broadly on curriculum reform or other areas of learning, limiting its impact on science specifically. Transition arrangements between primary and secondary schools are similarly variable. While a few leaders engage in dialogue with secondary colleagues about curriculum content or experiences, in many cases this work does not extend to shared understanding of pedagogy or pupils' prior learning. As a result, leadership approaches to collaboration and transition do not consistently secure coherent progression in science for all pupils.

Professional learning

Across the primary schools visited, a majority of leaders place emphasis on supporting staff through internal professional learning and collaborative approaches to developing science provision. In these schools, leaders make purposeful use of co-planning, staff meetings and informal professional dialogue to support teachers' confidence in planning and delivering science, often drawing on internal expertise to share practice. In a few schools, leaders use structured approaches, such as joint work scrutiny or shared reflection on classroom practice, to strengthen collective understanding of science teaching. However, access to high-quality, science-specific professional learning beyond the school remains limited in most schools. As a result, professional learning in science often focuses more on resources or thematic planning than on developing subject knowledge and science pedagogy. This constrains leaders' capacity to deepen staff expertise consistently and results in variation in teachers' confidence and understanding of effective science practice.

Professional learning in science supports teachers' understanding of progression to varying degrees across the schools visited. In a minority of schools, targeted professional learning, often supported by collaboration with secondary colleagues, has helped teachers develop a clearer understanding of how scientific knowledge and skills should build over time. In these schools, teachers are more confident in using long-term plans to sequence learning appropriately and revisit concepts at increasing levels of complexity. However, in a majority of schools, professional learning focuses more on pedagogy or curriculum design in general, with less emphasis on deepening teachers' understanding of scientific progression. As a result, teachers do not always have a secure grasp of the conceptual 'step-ups' between year groups, and progression is sometimes interpreted as repeating activities rather than developing understanding. Where professional learning is less closely aligned to science-specific progression, variation remains in how confidently teachers plan for depth and continuity in pupils' learning over time.

Leading and improving in the secondary phase

Internal leadership, culture and collaboration

Across secondary and all-age schools, the effectiveness of leadership, professional culture and collaboration in science is too variable. In stronger practice, leaders have established clear departmental structures and expectations that promote professional dialogue, collaborative planning and the sharing of effective practice within science teams. Where this is the case, senior leaders provide an appropriate balance of autonomy and accountability, enabling middle leaders to lead improvement in ways that take account of the disciplinary, curricular and practical demands of science. However, this level of collaborative culture is not evident in all schools. In many schools, collaboration within science departments is informal and uneven, often reliant on individual commitment rather than well-established leadership systems. Recruitment challenges and the use of non-specialist teachers further constrain leaders' capacity to develop cohesive teams and sustain consistent approaches to improvement. As a result, opportunities for collective professional learning and shared pedagogical development in science vary considerably between schools.

Leaders' approaches to internal leadership and collaboration influence how effectively science provision is reviewed and understood. Where leadership structures and professional cultures are more secure, leaders are better placed to gather and interpret evidence about science teaching and learning. However, variability in leadership capacity and collaborative practice across schools is reflected in the differing depth and precision of quality assurance and evaluation in science.

Quality assurance and evaluation

Across the secondary and all-age schools visited, leaders have established quality assurance and evaluation processes for science, but the effectiveness of these varies considerably. In many schools, leaders undertake regular monitoring activities, including lesson observations, learning walks, book scrutiny and analysis of assessment information, often in line with whole-school self-evaluation cycles. Analysis of attainment data, including cohort and item-level performance, provides valuable and objective insights into pupils' outcomes and supports leaders to identify broad trends. However, in a majority of schools, evaluation of science does not focus sharply enough on the quality of pedagogy or on how well pupils develop their scientific understanding and skills over time. While data analysis is an essential component of self-evaluation, it is not always complemented by sufficiently detailed consideration of how teaching approaches influence pupils' learning. Monitoring activity can therefore emphasise coverage, compliance with planning or headline attainment outcomes without examining closely the impact of classroom practice. In a minority of schools, leaders use a broader range of evaluation evidence more effectively to inform departmental improvement planning and professional dialogue. Overall, although quality assurance processes are in place in most schools, leaders' use of evaluation to gain a precise and secure understanding of strengths and weaknesses in science teaching and learning remains inconsistent.

Resource allocation, recruitment and retention

Across the secondary and all-age schools visited, leaders generally give careful consideration to the allocation of curriculum time, staffing and resources for science, although the extent to which this secures consistently strong provision varies.

In many schools, leaders allocate appropriate curriculum time for science across key stages and structure timetables to support progression, particularly at GCSE and post-16. In these schools, most lessons are taught by subject specialists, and leaders make effective use of available resources, including laboratories and technical support, to enable practical work. However, in a minority of schools, staffing constraints and financial pressures place limitations on timetabling and curriculum design. In these contexts, leaders are required to make pragmatic decisions, such as prioritising specialist teaching over lesson time or limiting curriculum breadth, which can reduce pupils' access to practical experiences or subject depth, particularly in Year 10 and Year 11. These staffing and resourcing decisions are closely linked to wider challenges around recruitment and retention of specialist science teachers.

A minority of schools, especially Welsh-medium schools and those in more rural areas, experience significant difficulties in recruiting and retaining specialists, most notably in physics and, to a lesser extent, chemistry. In these schools, leaders rely increasingly on non-specialists or cross-specialist teaching, particularly in lower year groups, and put support measures in place to mitigate the impact on provision. While many leaders work hard to support non-specialist staff through mentoring, shared resources and internal professional learning, staffing instability limits leaders' capacity to sustain consistent approaches and build long-term expertise within departments.

Professional learning

Across the secondary and all-age schools, internal professional learning plays an important role in supporting science teaching and leadership, although its focus and impact vary. In many schools, leaders provide regular opportunities for professional dialogue through departmental meetings, joint planning, coaching and the sharing of practice, often aligned with whole-school priorities for teaching and learning. These approaches support consistency and enable staff to reflect on aspects of practice. In a few schools, internal professional learning is particularly well developed, with structured subject-focused sessions, mentoring for new or non-specialist staff, and clear leadership roles dedicated to professional development. However, in a majority of schools, internal professional learning in science is largely generic and does not focus sharply enough on developing subject-specific pedagogy or deepening disciplinary knowledge. As a result, while staff benefit from collaboration and support, internal professional learning does not consistently support teachers' understanding of how to improve pupils' learning.

Alongside this, support for science from local authorities and school improvement services is limited and uneven. In a majority of schools, leaders report a significant reduction in subject-specific support, networks and advisory input for science in recent years. Where support is available, it is often perceived as evaluative rather than developmental or focused primarily on accountability and examination outcomes rather than on curriculum design or pedagogy. In a few schools, leaders value targeted input from regional officers or local authority advisers, particularly where this supports leadership development or provides external validation of departmental work. However, for many schools, the lack of sustained, science-specific external support constrains leaders' capacity to access specialist guidance, engage in professional networks and strengthen improvement activity beyond the school.

Building a strong professional learning culture through collaborative leadership

Leaders at **St Martin's School** have established a strong and purposeful professional learning culture in science, underpinned by effective collaborative leadership. A feature of this work is the clear and complementary partnership between the head of science and the second in department, whose explicit remit is to lead on teaching and learning and professional development.

Professional learning is carefully planned, regular and subject specific. It is built into the school timetable and aligned closely with both whole-school priorities and the identified needs of science teachers. Leaders place a strong emphasis on improving the quality and impact of classroom practice, rather than compliance or task completion. As a result, professional learning focuses on agreed pedagogical priorities such as retrieval practice, spaced learning, effective questioning and planning for misconceptions.

Teachers work together routinely to refine schemes of learning, share effective strategies and reflect honestly on what is working well and what needs further development. This culture is supported by effective quality assurance processes, including joint lesson observations, work scrutiny and professional dialogue with senior leaders. These processes are used constructively to inform professional learning priorities and strengthen consistency across the department.

Staff speak positively about the support they receive and value the opportunity to learn from one another. Leaders model reflective practice and encourage professional challenge, which has helped to secure high levels of staff confidence, consistency and job satisfaction. This sustained focus on collaborative professional learning is focussed on strengthening teaching quality across the department and in improving pupils' learning experiences in science.

Where science teachers engage in professional networks, these provide valuable opportunities for them to share ideas, discuss curriculum approaches and reflect on practice with colleagues beyond their own schools. In a few cases, teachers use networks to moderate expectations, exchange resources and strengthen professional confidence, particularly where subject-specific expertise is limited internally. However, participation in such networks is inconsistent. In a few schools, science teachers do not attend networks provided by the local authority, which limits opportunities for external collaboration and reduces access to shared learning and support beyond the school.

Across the secondary and all-age schools, science-specific professional learning is often narrowly focused and episodic. In many schools, subject-related professional learning is accessed primarily through examination board activity, such as marking or moderation, which strengthens understanding of assessment requirements but does not support the development of subject pedagogy. In a few schools, leaders supplement this through engagement with national subject organisations or higher education partners, although this is typically limited in scope and dependent on individual staff involvement. As a result, science-specific professional learning is rarely experienced as a sustained or coherent programme, and opportunities to build shared pedagogical understanding across departments are limited.

In around half of schools, professional learning plays an important role in strengthening teachers' understanding of progression in science. In these schools, subject-specific professional learning focuses on curriculum design, conceptual sequencing and shared understanding of what pupils should know and be able to do at different stages. Collaborative planning, regular departmental dialogue and coaching approaches help teachers reflect on practice, identify conceptual gaps and refine how learning builds over time. In the strongest examples, professional learning supports consistency across classes and enables teachers to anticipate where pupils are likely to encounter difficulty, improving coherence in teaching approaches. However, in around half of schools visited, professional learning is either infrequent or focused more broadly on pedagogy rather than on science-specific progression. As a result, teachers' understanding of how scientific knowledge develops across key stages remains variable and relies heavily on individual expertise or experience. Overall, where professional learning is well aligned with curriculum intent, it supports more coherent progression.

Wider system support and challenges

Local authorities and school improvement services

Across the schools visited, there is considerable variation in the level and consistency of support for science provided by local authorities and school improvement services. While a minority of areas have established more structured approaches, support for science is less developed, as improvement work has tended to prioritise literacy and numeracy. In many areas, challenges in recruiting and retaining specialist science teachers, particularly in physics, chemistry and in Welsh-medium settings, continue to affect and contribute to the use of non-specialist teachers, especially in Year 7 to Year 9. Although there are emerging examples of collaborative curriculum development and progression work between schools, this remains uneven and is often dependant on individual leaders rather than well-coordinated system support. In a few areas, subject-specific support prioritised appropriately within school development planning.

Local authorities and school improvement services provide a suitable range of actions to strengthen advisory support for science. These include the development of science-specific professional learning for non-specialist teachers, early career teachers and aspiring subject leaders, alongside the establishment of subject networks and departmental forums focused on pedagogy and curriculum design. In some areas, advisory staff have provided coaching, mentoring and team-teaching to support improvement directly in classrooms, particularly where non-specialist teaching is prevalent. A minority of authorities have supported cluster-based work to map progression and develop shared curriculum approaches across primary and secondary schools, and a few have formed partnerships with higher education institutions and subject organisations to supplement advisory capacity. Despite these efforts, representatives acknowledged that access to science-specific advisory support remains inconsistent, participation in professional learning is constrained by workload and staffing pressures, and provision for Welsh-medium science continues to be limited by shortages of specialist expertise and suitable resources.

Welsh-medium provision

Leaders demonstrate a strong commitment to ensuring that pupils experience science through the medium of Welsh. In both primary and secondary settings, they place importance on sustaining the linguistic ethos of their schools and on enabling pupils to access scientific knowledge and experiences confidently in Welsh. However, the extent to which leaders are able to secure consistently high-quality Welsh-medium science provision varies across the sample, reflecting differences in access to resources, professional learning and external support.

In nearly all of the Welsh-medium primary, secondary and all-age schools visited, leaders support science teaching effectively by adapting curriculum materials, developing shared planning resources and agreed scientific terminology in Welsh, and encouraging collaborative approaches that strengthen staff confidence and reduce reliance on direct translation. Where this support is strongest, leaders foster a shared understanding of language expectations and greater consistency in provision. However, in a majority of these schools, leaders report limited access to high-quality Welsh-language science resources and subject-specific professional learning. As a result, although technological advances have lessened the burden, teachers continue to adapt or translate English-medium materials, which increases workload and places additional demands on staff. In these contexts, leaders' capacity to secure consistent, accessible and high-quality Welsh-medium science provision is constrained, and pupils' experiences vary depending on the expertise and capacity leaders are able to secure within their teams.

Leaders' ability to strengthen Welsh-medium science provision is further influenced by the availability of system-level support. Evidence from discussions with Adnodd indicates that there is clear strategic recognition at national level of the historic under-availability of Welsh-medium resources, including in science. Adnodd has established a coherent strategic framework to address these gaps, with funding in place and partnerships formed with learned societies, universities and language specialists to support the development of high-quality bilingual resources aligned with the Curriculum for Wales. The use of co-authoring approaches, where resources are developed simultaneously in Welsh and English rather than translated, represents a significant step towards improving linguistic equity and accessibility.

However, this work remains at an early stage of implementation. While leaders welcome the direction of travel, many schools report that current Welsh-medium science provision continues to depend on interim solutions while new resources are developed. Extended timelines for the availability of bilingual science materials reduce their immediate impact on classroom practice. In addition, although quality assurance processes for language accessibility and terminology are strengthening, there is currently limited evidence of systematic evaluation of how new resources affect teaching quality or pupils' experiences of science through the medium of Welsh.

Overall, Welsh-medium science provision reflects a strong commitment from leaders at school and national level to equity and inclusion. However, variability in resourcing, professional learning and external support means that pupils' experiences of science through the medium of Welsh are not yet consistently comparable with those of their English-medium peers. The findings indicate that strengthening Welsh-medium science provision depends not only on the availability of resources, but also on leaders' capacity to integrate these effectively into curriculum planning, professional learning and classroom practice.

Initial teacher education partnerships

Recruitment to secondary science initial teacher education (ITE) programmes in Wales remains challenging, particularly in physics and chemistry. Recruitment levels are affected by wider national shortages, competition from alternative graduate pathways offering higher salaries, funding differentials with England and limited placement capacity in some regions. These challenges are especially acute for Welsh-medium provision and in more rural areas. Although most providers indicated that many trainees remain in Wales following qualification, current recruitment levels are insufficient to meet schools' ongoing staffing needs.

ITE partnerships outlined a range of actions aimed at strengthening recruitment and improving retention. These include targeted promotion of science teaching routes, closer collaboration with schools to improve the quality and availability of placements, and increased flexibility in delivery models. Providers described work to strengthen trainees' confidence in teaching science through a clearer focus on Curriculum for Wales, enhanced subject-specific input where possible, and greater emphasis on mentoring and support for non-specialists. Several partnerships are also developing stronger links with higher education institutions, subject organisations and school improvement services to enrich trainees' subject knowledge and pedagogy. However, further system-wide action is required to improve the attractiveness and sustainability of science teaching routes in Wales, particularly for shortage subjects and Welsh-medium pathways.

Methods and evidence base

The thematic report draws on evidence from visits to 16 primary schools, 4 all-age schools and 19 secondary schools across Wales. These visits were selected to represent a wide geographical and socio-economic spread, and included English-medium, Welsh-medium and bilingual settings. The visits were undertaken in the autumn term of 2025. During our school visits we:

- carried out lesson observations and learning walks
- interviewed senior and middle leaders
- interviewed groups of pupils across the primary and secondary phases
- reviewed documentation and relevant resources

In addition to our school visits, we also met with other stakeholders including:

- local authorities and regional support services
- initial teacher education partnerships
- Adnodd

Additionally, we conducted a desktop review to gather relevant documentation related to the review's focus. This included an analysis of recent publications and resources, including previously published Estyn thematic reports.

Estyn would like to thank all those involved in this thematic review.

Provider Name	Local Authority	Sector
Beaufort Hill Primary School	Blaenau Gwent	Primary
Bishopston Primary School	Abertawe	Primary
Castle Park Primary School	Monmouthshire	Primary
Halfway C.P. School	Carmarthenshire	Primary
Henllys C.I.W. Primary School	Torfaen	Primary
Maindee C.P. School	Newport	Primary
Penyrheol Primary School	Swansea	Primary
Rhos Primary School	Neath Port Talbot	Primary
Ysgol Cynwyd Sant	Bridgend	Primary
Ysgol Gymraeg Dewi Sant	The Vale of Glamorgan	Primary
Ysgol Gymraeg Ifor Hael	Newport	Primary
Ysgol Gynradd Pencarnisiog	Isle of Anglesey	Primary
Ysgol Morfa Rhianedd	Conwy	Primary
Ysgol Nant Y Groes	Conwy	Primary
Ysgol Pen Y Pil	Cardiff	Primary

Ysgol Y Manod	Gwynedd	Primary
King Henry VIII 3-19 School	Monmouthshire	All-age schools
Porth Community School	Rhondda Cynon Taf	All-age schools
Ysgol Bro Idris	Gwynedd	All-age schools
Ysgol Gymraeg Bro Morgannwg	The Vale of Glamorgan	All-age schools
Bryncelynnog Comprehensive School	Rhondda Cynon Taf	Secondary
Cardiff High School	Cardiff	Secondary
Cefn Hengoed Community School	Swansea	Secondary
Coedcae School	Carmarthenshire	Secondary
Crickhowell High School	Powys	Secondary
Cwmtawe Community School	Neath Port Talbot	Secondary
Cynffig Comprehensive School	Bridgend	Secondary
Eirias High School	Conwy	Secondary
Lewis School, Pengam	Caerphilly	Secondary
Llanishen High School	Cardiff	Secondary
Llanwern High School	Newport	Secondary
St Martin School	Caerphilly	Secondary
The Bishop Of Llandaff C.I.W. High School	Cardiff	Secondary
Ysgol Bro Gwaun	Pembrokeshire	Secondary
Ysgol Gyfun Aberaeron	Ceredigion	Secondary
Ysgol Gyfun Cwm Rhymni	Caerphilly	Secondary
Ysgol Gyfun Penweddig	Ceredigion	Secondary
Ysgol Uwchradd Bodedern	Isle of Anglesey	Secondary
Ysgol Y Moelwyn	Gwynedd	Secondary

Glossary

Area of Learning and Experience (Area)	Areas of Learning and Experience – The six areas in the Curriculum for Wales: Expressive Arts; Health and Well-being; Humanities; Languages, Literacy and Communication; Mathematics and Numeracy; and Science and Technology
Conceptual understanding	A pupil's understanding of the key ideas in science, not just the ability to recall facts or complete activities.
Curriculum coherence	The extent to which different parts of the curriculum fit together logically so that pupils' learning makes sense and builds over time.
Curriculum sequencing	The order in which learning is designed so that pupils can develop understanding step by step, with earlier learning supporting later learning.
Disciplinary knowledge	Subject-specific knowledge linked to particular scientific disciplines, such as biology, chemistry and physics.
Enquiry-led learning	An approach where pupils learn by exploring questions, problems or challenges, often through investigation and discussion.
Progression steps	Broad age-related reference points in the Curriculum for Wales that describe how learning is expected to develop as pupils develop.
Scientific reasoning	The ability to use evidence, logic and scientific knowledge to explain ideas, make predictions and solve problems.
Thematic planning	An approach to curriculum planning where learning is organised around themes or topics, often linking different subjects together.

Numbers – quantities and proportions

nearly all =	with very few exceptions
most =	90% or more
many =	70% or more

a majority =	over 60%
half =	50%
around half =	close to 50%
a minority =	below 40%
few =	below 20%
very few =	less than 10%

References

Education Endowment Foundation (2018) *Improving Secondary Science.* Available at: Improving Secondary Science | EEF (Accessed: 30 April 2025)

Education Endowment Foundation (2023) *Improving Primary Science.* Available at: Improving Primary Science | EEF (Accessed: 30 April 2025)

Estyn (2017) Science and design and technology at key stage 2 Cardiff. (Accessed: 9 May 2025

Estyn (2017) Science at key stage 3 and key stage 4 Cardiff (Accessed: 9 May 2025)

https://www.gatsby.org.uk/education/programmes/support-for-practical-science-in-schoolshttps://doi.org/10.1039/d1rp00168jhttps://doi.org/10.1080/19415257.2020.1752289
Hwb (2020) *Area of Learning and Experience: Science and Technology*. Available at: Science and Technology: Introduction - Hwb (Accessed: 28 April 2025)

https://www.nuffieldfoundation.org/project/effective-practical-work-primary-school-science
Ofsted (2021) *Research review series: science.* Available at: Research review series: science - GOV.UK (Accessed: 28 April 2025)

https://www.gov.uk/government/publications/subject-report-series-science/finding-the-optimum-the-science-subject-report--2
https://doi.org/10.3389/feduc.2023.1151641https://cms.wellcome.org/sites/default/files/science-content-in-primary-initial-teacher-training.pdfWelsh Government (2023) *PISA 2022: National Report for Wales.* Available at: PISA 2022: National Report for Wales (Accessed: 9 May 2025)