CAMBRIDGE
UNIVERSITY PRESS & ASSESSMENT

Centre for Evaluation & Monitoring

Science & Maths

Using baseline assessments to improve outcomes in Science & Maths

Biology, Physics, Chemistry, Geology, Maths, PE & Sport, Health & Social Care, Child Development

Cambridge CEM data allows teachers to gain valuable insights into their students' cognitive strengths and weaknesses, enabling them to adapt teaching strategies, resources and pace in lessons to meet the needs of individual students and to enhance learning outcomes. However, to do this effectively, Cambridge CEM data should not be used in isolation from other information teachers know about their students. This is especially important when students are not reaching their potential.

Verbal reasoning ability

Strong spoken and written verbal reasoning skills are essential for success in Science and Maths subjects: for written and oral communication and the ability to research, analyse and evaluate information. The two aspects of verbal reasoning are receptive language – the words which we understand; and expressive language – using the words we understand in spoken and written communications. Cambridge CEM's Vocabulary test measures receptive language and the speed with which students recall the meaning of the words (fluency). In interpreting Cambridge CEM Vocabulary scores, teachers need to be aware of students' strengths and weaknesses in their broader language skills. Scoring highly on Vocabulary but having poor expressive language skills means being unable to express the language they understand at the level the test score suggests.

Non-verbal/visual reasoning (NVR)

NVR skills are very closely associated with science and maths subjects because strong NVR and visual reasoning skills are required if students are to make sophisticated connections between visual and other elements. The Cambridge CEM Non-verbal/Patterns tests assess a student's ability to match patterns, reflections and rotations and apply visual intuition. These skills are important for:

- thinking creatively, innovatively, analytically, logically and critically
- problem solving
- organising information
- researching
- analysing and evaluating information
- determining the appropriateness and limitations of different resources
- being reflective and empathetic
- making substantiated judgements.

Mathematics

Crucial to success in most qualifications in this subject area is having well-developed mathematical skills. Cambridge CEM's Mathematics tests, being timed assessments, also give an indication of speed of working, rather than overall mathematical ability per se. A student might have a lower Mathematics score than expected because they work slowly, so perhaps they need extra time.

Mathematics and non-verbal reasoning

These two areas are closely related. A student might be significantly more able in one than the other, which is likely to cause difficulties in science and maths subjects. For example, a student with a high mathematics score might be able to solve calculations in maths, physics or chemistry, but because of their significantly lower non-verbal score, they find it difficult to make justified decisions when using data. This includes its selection, interpretation, analysis and evaluation, as well as identifying the quantitative information required to provide adequate data analysis of, for example, their training programme in sports science. Conversely, a student with high non-verbal reasoning might be adept at problem solving and developing design specifications, which are effectively evaluated, but because of numeracy difficulties, they need support to remember methods.

Verbal and non-verbal reasoning work together: executive functions

It is important to realise that verbal and non-verbal skills are interdependent; inextricably linked and difficult to separate.

Executive functions are also non-verbal skills, enabling us to successfully understand language, communicate and interact socially.

Flexible thinking: to understand implied information and to be open to other points of view.

Task initiation: to initiate a conversation or written task.

Plan, prioritise & organise verbal or written communications.

Working memory: mentally manipulate information to follow conversations or comprehend what we read.

Self-monitoring: monitor and modify our behaviour.

Emotional regulation: maintain appropriate emotions.

Impulse control: to control our behaviour; respect personal space and avoid behaviours like interrupting.

These are not measured by Cambridge CEM tests, so it is important teachers use the additional knowledge they have about individual students to explain why they might be underachieving.

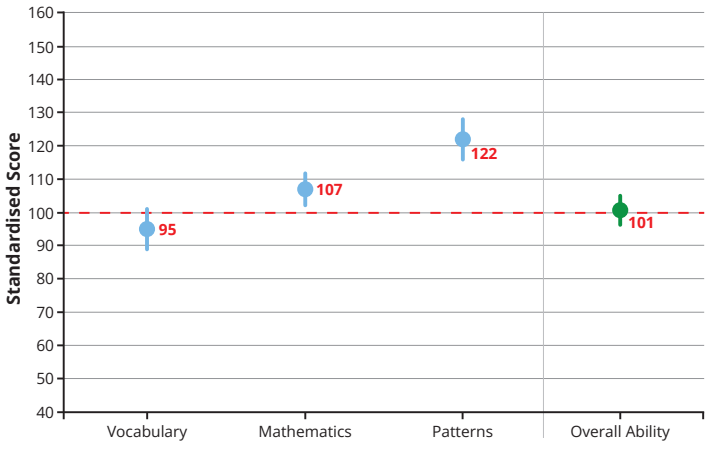
Adaptations for weak executive skills

Provide various graphic organisers to sort information e.g. mind mapping; flow charts; templates as allowed by the specification. Explicitly show important information in lesson notes. As permitted in the qualification, provide 'how to…' crib sheets, explicit checklists for assignments, and personalised checklists for the most common errors. Breakdown assessed tasks into chunks, as allowed. Display instructions for tasks. Get attention with phrases like, "This is important to know because…" Give frequent reviews to previous learning.

Discrepancies in cognitive profiles

The scores are **standardised**, with a mean of 100 (absolute average) and a standard deviation of 15. Individual Student Reports (ISR) show a 95% confidence limit for each score, which identify strengths and weaknesses in performance. When confidence limits do not overlap, the scores are statistically significant (resulting in a discrepancy), indicating notable strengths and weaknesses. Understanding these provides likely reasons why students are working below expectations.

Cognitive profile example I (from Yellis):



For this student, non-verbal reasoning (Patterns) is a relative strength, enabling them to interpret diagrammatic information, problem solve and undertake practical work successfully. In PE & sport, for example, they will be able to analyse and evaluate the factors underpinning their performance. However, compared with their NVR, their numerical ability and their speed of working are relative weaknesses. These discrepancies might impact the quantitative work in all science and maths subjects. They might 'see' the solution, but knowing how they reached it mathematically will take longer. A mid average Vocabulary score suggests receptive language is sound, but teachers must ensure the student's expressive language skills are, too.

Adaptations for weaker maths

Explain to students why knowledge of maths is essential for their practical work and for success in the subject. Share subject-specific real-life examples to promote relevance.

Provide explicit step-by-step instruction sheets on how to solve specific calculations and problems, along with guided practise. Use colour to highlight signs or tricky parts of equations.

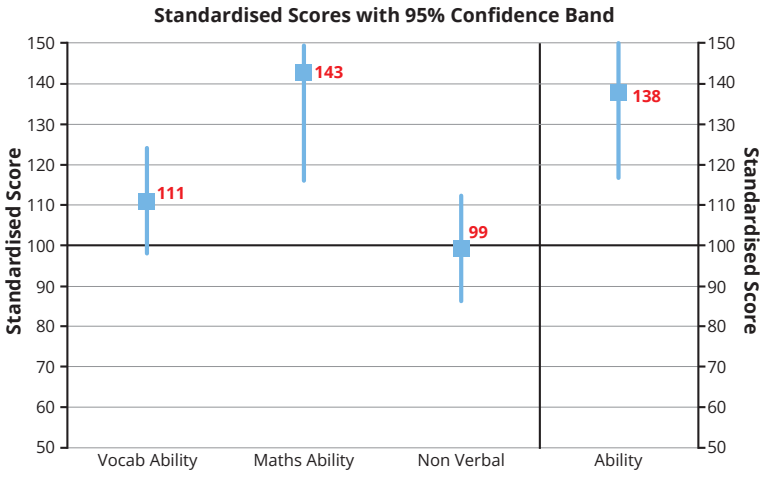
Address misconceptions through directed Q & A. Use careful pairing so a more able student can explain concepts to a less able peer.

Use flashcards to practice recalling information from memory and apply it to different contexts, such as solving algebraic equations in the context of geometry problems.

Case study

Jamie has attention deficit hyperactivity disorder (ADHD). His Cambridge CEM Yellis scores are Vocabulary 116, Maths 95 and Patterns 81. His relatively high Vocabulary is compromised by his significantly weaker NVR. Both his verbal and written language are poorly structured and confused. He needs support in planning and organising written work. He struggles to interpret diagrammatic information, and problem solving and decision making are a challenge. Although he enjoys maths, as his teacher has made concrete apparatus and mathematical games a common feature in the class, he struggles to apply his maths skills in physics. Typing his work is his normal way of working. In addition, his lack of focus and weak NVR mean he takes longer than expected to process information, especially when reading text. His teacher provides him with rest breaks to refocus and explicit guided reading assistance to support his understanding and develop his analytical and problem-solving skills.

Cognitive profile example 2 (from Alis):



Maths Ability is a relative strength compared with Non-Verbal. This student is likely to be able to solve calculations quickly, but they will find problem solving and the more practical elements of courses more challenging. They will need support to interpret pictures and diagrams. Applying their knowledge from maths and science might be deficient, impacting their analysis and evaluation skills, and the formulation of substantiated judgements. Despite having a high average Vocabulary score, verbal and written expression might be weaker.

Adaptations for weak NVR

The overarching principle to support weak NVR skills is to make the abstract as explicit, tangible and concrete as possible to support difficulties in complex, abstract reasoning. Use modelling when interpreting pictures and diagrams. Demonstrate practical tasks. Use real-life examples to allow students to put themselves in the shoes of industry professionals. For example, in health & social care, the effects on service users if person-centred values are not applied. Develop empathy through real-life scenarios and role play. Encourage intellectual curiosity by questioning why things are done the way they are to improve problem-solving skills, develop out-of-the-box thinking and find solutions.

Develop key writing skills: model clear sequences through shared activities and thinking aloud about key decisions. Check understanding often; invite questions to develop creative thinking and problem-solving skills. Explicitly draw together knowledge, skills, understanding and explanations across different elements of the specification. Use specialist subject-specific terminology precisely to analyse and compare, make informed arguments, reach substantial judgements and draw conclusions.

Adaptations for weak language skills

Provide memory hooks to learn subject-specific vocabulary: posters; word mats; flash cards; Pelmanism games to match key words and definitions. Match labels to illustrations to assist memorization e.g., in biology and PE.

Ensure students understand the difference between command verbs e.g., ‘describe’ and ‘evaluate’.

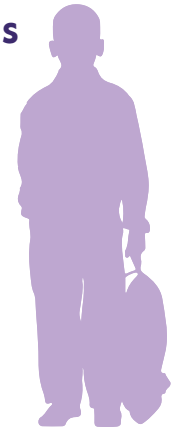
Summarise notes using structures like the 5Ws: Who? Why? What? Where? When? Use the 5Ws to develop critical thinking, debate and the formation of personal judgements.

Secondary Baseline Assessments

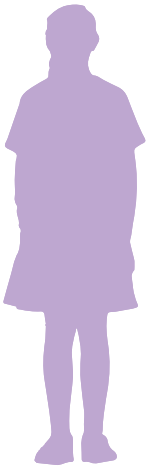
Cambridge CEM's secondary baseline assessments are there so you can discover and progress your students' potential as throughout secondary school.

Spanning across all learning stages, our MidYIS (11-14), Yellis (14-16) and Alis (16-19) assessments are designed to help predict up to GCSE, IGCSE A-Level and IB. They test a range of sections including vocabulary, maths and non-verbal skills, with an average duration of 50 minutes per assessment.

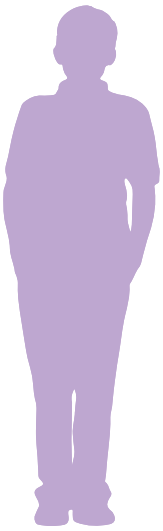
Midyis (11-14)



Yellis (14-16)



Alis (16-19)

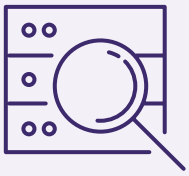


How can Cambridge CEM's data help you?

Baseline data

Map what your students know

- Identify students' starting point
- Diagnose gaps in learning
- Shape your teaching to meet your students' learning needs
- Information at student, class, subject and school level



Predictive data

Set targets and plan next steps

- Indicators to grades at GCSE, IGCSE, A Level and IB Diploma
- Set challenging targets
- Plan your interventions to help students improve on areas of weakness
- Support students' progress with confidence

Longitudinal data

Monitor trends over time

- Monitor cohort performance over time
- Identify trends over time
- Compare previous years' performance
- Target resources effectively

Value-added data

Review success and share best practice

- Evaluate student outcomes
- Value-added reports
- Measure the impact of your teaching
- Share best practice and identify areas for school improvement

To find out more about Cambridge CEM's baseline assessments, visit **www.cem.org/assessments**

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