GL Education®

TEACHER GUIDANCE – INTERNATIONAL EDITION

CAT4®

COGNITIVE ABILITIES TEST

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GL Education

INTRODUCTION

CAT4

COGNITIVE ABILITIES TEST

In this section

What is *CAT4*?

The Cognitive Abilities Test Fourth Edition (*CAT4*) is a suite of tests developed to support schools in understanding students' abilities and likely academic potential. Results from *CAT4* can be used to inform individual and group teaching, for target setting and monitoring the performance of groups of students.

CAT4 assesses the ability to reason with and manipulate different types of material. *CAT4* comprises four batteries of tests that assess the main types of mental processing that play a substantial role in human thought. Together, these four batteries provide users with a comprehensive understanding of the core abilities related to learning by assessing a student's capabilities when dealing with each type of processing.

The *CAT4* batteries assess:

- reasoning with words
- reasoning with numbers
- reasoning with shapes and designs
- thinking with and mentally manipulating precise shapes.

The set of four scores obtained from assessment with *CAT4* provides a profile of a student's abilities, as well as providing an overall summary score of his or her reasoning abilities across the four areas.

During the development of *CAT4*, the authors emphasised the assessment of relational thinking; that is, the ability to understand relationships among elements using the media of the four test batteries. The basic elements of each test have been kept simple and clear to ensure the tests are accessible to students of the appropriate age for each test level.

The Spatial Ability and Nonverbal Reasoning Batteries

The Spatial Ability Battery is designed to assess how well students can create and retain mental images of precise shapes and objects, and then manipulate these in their minds. This ability is critical to effective working in many 'spatial' disciplines and careers (for example, engineering, physical sciences, mathematics and architecture). Yet it has traditionally been under-appreciated or under-assessed in schools, either being ignored completely or viewed as relevant only to 'low-level' manual skills.

For this reason, students who excel in such thinking have been under-identified and therefore not properly encouraged to actualise their potential. Perhaps as a consequence, spatial disciplines have struggled to obtain enough recruits, and those they do recruit have sometimes not been best suited to the demands of the work, having been chosen on the basis of inappropriate ability measures, family pressure or gender stereotyping – for example, 'engineering is a man's job'.

Students with a high spatial ability may be well-suited to jobs involving visual mapping, such as architecture, graphic design, photography and astronomy.

In recent decades, major longitudinal research projects have conclusively shown that spatial ability is a significant element underlying performance in spatial disciplines. Also, it has been found that those who are most likely to pursue and excel in these domains are people with a relative strength in spatial ability, rather than necessarily those who do well in all types of ability tests. The balance of abilities – even a small difference within a person who has a very high level of general ability – seems critical for career choice and success. Assessing people solely on verbal and mathematical tests is therefore likely to miss many of those with the highest potential to succeed in spatial careers. Such research is presented succinctly in *Recognizing Spatial Intelligence* (Park et al., *Scientific American*, November 2010).

Due to the neglect of spatial ability in school curricula, traditional standardized assessments, and in national talent searches, those with relative spatial strengths across the entire range of ability constitute an under-served population with potential to bolster the current scientific and technical workforce.

The Nonverbal Reasoning Battery is designed to measure something distinct from the Spatial Ability Battery. The materials used are still shapes but the difficulty of the task lies not in creating, maintaining and mentally manipulating precise images but in reasoning with easily distinguishable shapes and designs. Like the Verbal and Quantitative Reasoning Batteries, it measures basic reasoning processes such as identifying similarities and relationships by using shapes and designs rather than words or

The Nonverbal Reasoning Battery is designed to measure something distinct from the Spatial Ability Battery.

numbers as the stimulus material. For this reason, it provides a means by which those with a spatial bias can demonstrate how effectively they can engage in general reasoning processes.

However, the fact that the shapes and designs used are easy to distinguish means that those with a verbal bias can also succeed on the Nonverbal items, by describing the shapes and designs in words and then reasoning out the solution verbally – for example, ‘large circle goes to small circle and two horizontal lines are added’. This flexibility in solving the Nonverbal items means that the battery provides a good indication of students’ ability to solve problems using whatever cognitive resources they can muster. It is therefore not surprising that research has shown that Nonverbal tests often relate closely to overall scores on large batteries of different tests.

Although all four batteries are equally weighted in the mean *CAT4* score for the four batteries, the Nonverbal Reasoning Battery consistently correlates at the highest level with that overall score, thus supporting this research. This makes the Nonverbal Reasoning Battery particularly important when assessing students whose performance on the Verbal and/or Quantitative Reasoning Batteries may not be representative so that the overall mean *CAT4* score needs to be treated with caution. This impairment may result from any number of reasons, such as poor educational background, specific learning difficulties or not speaking English as a first language.

For students who can be validly assessed with all four batteries, the introduction of the Spatial Ability Battery means that *CAT4* provides a clear measure of the extremes of thinking processes, namely, those using verbal processing (the ‘inner ear/voice’) and those using spatial processing (the ‘inner eye/hand’). Additionally, the Nonverbal and Quantitative Reasoning Batteries provide measures of the ability to think using both these types of processing together.

What is in each battery?

CAT4 consists of four test batteries, each of which contains two tests. These are described below.

CAT4	
Verbal Reasoning Battery	**Verbal Classification** **Verbal Analogies**
Quantitative Reasoning Battery	**Number Analogies** **Number Series**
Nonverbal Reasoning Battery	**Figure Classification** **Figure Matrices**
Spatial Ability Battery	**Figure Analysis** **Figure Recognition**

Verbal Reasoning Battery

In the **Verbal Classification** test, each question presents three words that are all similar in some way. Students have to identify the conceptual link between the three words and then select from a list of five further words the one which best fits with the first three. This test assesses general verbal reasoning and the ability to extract general principles from specific examples by identifying similarities and relationships between the concepts. Also assessed are general knowledge (for example, that an ankle is a joint), word knowledge (for example, that 'cold' can mean a virus or a low temperature) and language development (for example, that some words can be verbs or nouns, or how to use words like 'although' or 'moreover').

doubtful **confusing** **vague**

A false **B hidden** **C insecure** **(D) uncertain** **E fearful**

In the **Verbal Analogies** test, each question presents a verbal analogy in the form of ‘A→B: C→_’. Students have to work out how the first pair of words is related to each other and then select from five answer options the one that completes the second pair. These questions involve two elements to the reasoning. First, students have to look for similarities and differences between the first pair, for example the second thing is an element of the first or a descriptive term for the first. Second, they have to duplicate that relationship starting with the third word presented. Like Verbal Classification, this test also assesses general verbal and word knowledge.

blue → colour : socks →

A clothing **B** feet **C** shoes **D** pair **E** wear

Although the students’ store of general and word knowledge influences their performance on the Verbal Reasoning Battery, questions have been written to maximise the students’ flexibility in identifying and using concepts rather than taxing their background knowledge or vocabulary. As far as possible, the words used are likely to be commonly known at the level in which they are used. For example, ‘windy’ might be used in Level A but ‘hurricane’ in Level E. Questions emphasise general basic reasoning processes, with the relationships being presented in verbal terms.

Since the greater part of education is presented through the verbal medium, the importance of this battery for diagnosis and educational attainment is clear. Tests of verbal reasoning have always been among the best predictors of educational progress.

Quantitative Reasoning Battery

In the **Number Analogies** test, each question presents three pairs of numbers, such as ‘4→6, 8→10, 9→_’. Students have to work out how the pairs of numbers are related and then complete the third pair by selecting the answer from the five options presented. The questions in this test assess the same basic reasoning processes that are assessed in the equivalent Verbal Analogies test, namely, identifying relationships and creating further examples of them. The questions in this test also assess basic arithmetic knowledge (for example, that 6 is twice 3), accuracy in doing simple arithmetic and flexibility in identifying and being aware of numerical relationships (for example, that 7 might be twice 3 plus 1 or four times 2 minus 1).

[5 → 13] [11 → 19] [6 → ?] **A** 9 **B** 12 **C** 14 **D** 16 **E** 18

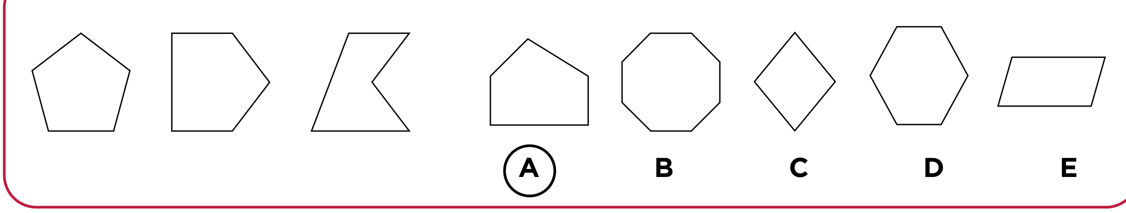
In the **Number Series** test, students have to work out the rule underlying the progression in the number series in each question and then select the next number in the series from the five options presented. This test assesses the same underlying basic reasoning processes and number facility as Number Analogies.

3 7 15 31 63 → **A** 94 **B** 96 **C** 97 **D** 127 **E** 137

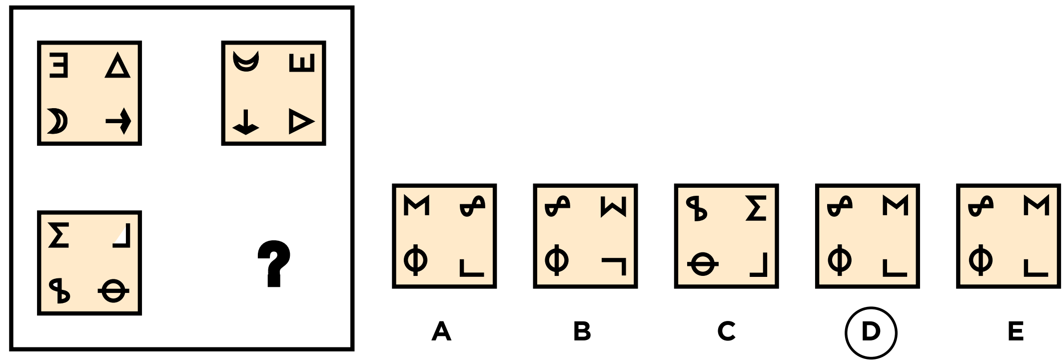
Next to verbal reasoning, the ability to work with numerical material is one of the most frequently required capabilities in educational settings. Fields such as mathematics, science, geography and economics make considerable demands on quantitative abilities. Quantitative reasoning together with verbal reasoning constitutes what some theorists have called 'academic ability', in that they were the two types of thinking that were most obviously represented in traditional school curricula.

Nonverbal Reasoning Battery

In the **Figure Classification** test, each question presents students with three separate figures and they have to identify the conceptual link or underlying characteristic that all three figures have in common. They then have to select the one figure from five answer options that goes with the first three. This test assesses the same underlying reasoning processes as the Verbal Reasoning Battery tests; that is, the ability to identify similarities, differences and relationships between elements. The ability to form representations of shapes is only involved at a very low level, so those demands are unlikely to impact upon the vast majority of students. Only the scores of those who cannot spot gross visual distinctions (for example, a 90° angle versus a 70° angle) would be adversely affected by the representational demands of the test. In all other cases, it is the reasoning processes that constitute the primary source of difficulty.



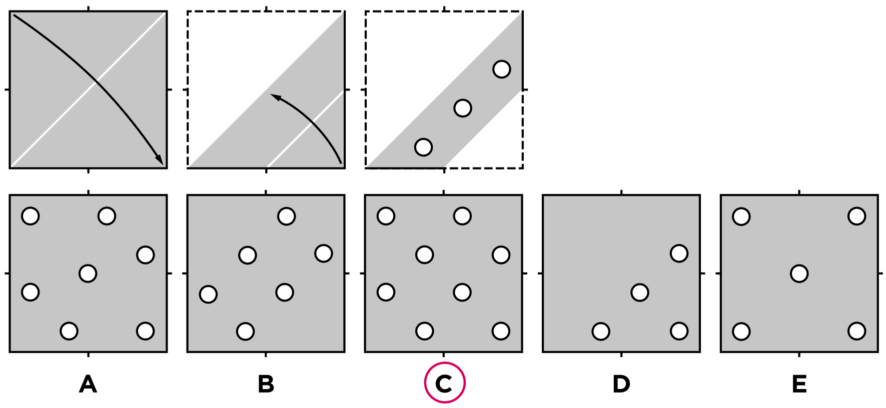
In the **Figure Matrices** test, each question presents a figural analogy in the form of 'A→B, C→_'. Students have to work out how the first pair of figures is related to each other and then select from five answer options the one that completes the second pair. The underlying reasoning processes used in solving Figure Matrices are essentially the same as those in Verbal Analogies and Number Analogies. Visualisation is assessed to a larger degree in this test compared with Figure Classification, as the questions require students to be able to use visual 'working memory' to imagine transformation and combinations of shapes.[1]



The tests in the Nonverbal Reasoning Battery do not make use of words or numbers, and the geometric and figural elements used bear little direct relationship to formal educational instruction. The tests emphasise the discovery of, and flexibility in, manipulating relationships expressed in figural designs.

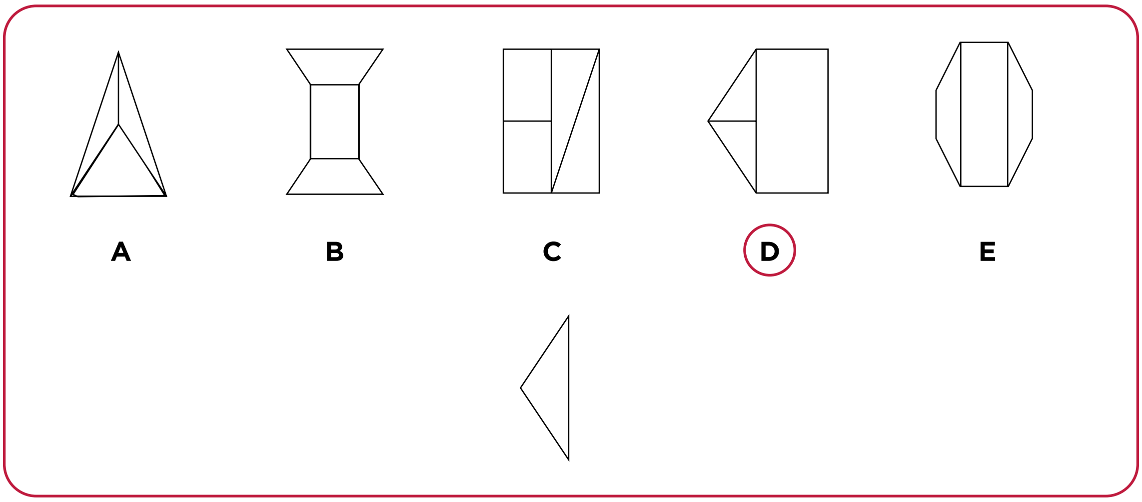
Spatial Ability Battery

In the **Figure Analysis** test, each question presents students with a square that is repeatedly folded and then has one or more holes punched through it. Students have to work out what the final product would look like when unfolded, and select this from the five answer options provided. This test assesses visualisation processes, that is the ability to create a complex mental image, retain it in mind and manipulate it before comparing the imagined result with other presented material.



[1] Working memory is the facility to retain and manipulate information (words, numbers and images) for a short time in order to perform a specific task – for example, the ability to remember a phone number or date, solve a mental maths problem or, in this case, hold the original shape in mind and imagine it transformed. Efficient working memory is essential for learning but the amount of information that can be held is limited and unstable particularly if an individual is distracted or distractible; if this happens the process has to be begun again!

In the **Figure Recognition** test, students are shown five complex designs as line drawings with a target shape below. Students have to identify which of the five designs contains the exact same size outline of the target, including each side in full. This test assesses visualisation skills, particularly the ability to create and retain a firm mental image of a shape that represents angles and lengths accurately.



As with the Nonverbal Reasoning Battery, the tests in the Spatial Ability Battery do not make use of words or numbers. Instead they emphasise visualisation and manipulation of mental images.

More about the batteries

Nonverbal and spatial tests have been found to be significant predictors of educational attainment, despite their content being generally unrelated to formal schooling. Among students with similar levels of verbal or quantitative ability, the Nonverbal and spatial tests can indicate significant aptitude for subjects such as mathematics, physics, design, engineering and architecture, which draw on visual-spatial abilities.

As the Nonverbal Reasoning and Spatial Ability Batteries do not rely on reading or the use of English, they can be particularly useful when assessing students who have English as an additional language, or who have reading difficulties or have experienced disrupted education. They are also not strongly influenced by other factors such as a child's cultural background, although caution needs to be exercised when interpreting results for children from non-Western backgrounds, as they may be unfamiliar with the type of material and tasks used.

Unlike the Verbal and Quantitative Reasoning Batteries, questions in the Nonverbal Reasoning and Spatial Ability Batteries do not require students to have any prior factual or conceptual knowledge of any kind, beyond that required to access the test instructions. These batteries therefore assess students' general cognitive capacity to solve novel problems they have not been directly taught. Where performance on the Nonverbal Reasoning or Spatial Ability Batteries is superior to that on the other two batteries, it may indicate that these students have potential that is not being fully shown in their performance on school-related tasks.

Among students with similar levels of verbal or quantitative ability, the nonverbal and spatial tests can indicate significant aptitude for certain subjects.

Across the four test batteries, similar question types have been included as far as possible. The purpose of this is to reduce variation in test performance that may be attributed to ability with, or understanding of, specific question types. For example, analogy tests have been included in the Verbal, Quantitative and Nonverbal Reasoning (Figure Matrices) Batteries. This means that students' profiles of results will more accurately reflect their reasoning ability with each type of material, rather than their ability to undertake different forms of test question.

How do I choose the test level?

CAT4 has 11 levels available to choose from. The levels are aimed at different age groups and the test content of each level is developed in an overlapping format of progression difficulty.

The target year group and age range covered by the norms for each test level are shown in the table below.

Recommended year groups

Age (years: months)	CAT4 level	Year (UK)	Grade (US)	Grade (Indian)	Grade (IB Programme)
6:00 – 7:11	X	2	1st	1st	1st PYP
6:06 - 8:11	Pre-A	3	2nd	2nd	2nd PYP
7:06 - 9:11	A	4	3rd	3rd	3rd PYP
8:06 – 10:11	B	5	4th	4th	4th PYP
9:06 – 11:11	C	6	5th	5th	5th PYP
10:06 – 12:11	D	7	6th	6th	6th MYP
11:06 – 13:11	E	8	7th	7th	7th PYP
12:06 – 15:11	F	9	8th	8th	8th MYP
	F	10	9th (Freshman)	9th	9th MYP
14:06 – 17:00+	G	11	10th (Sophomore)	10th	10th MYP
	G	12	11th (Junior)	11th	11th DP (Junior)

What test results can I obtain?

The number of questions a student answers correctly on each test is referred to as their raw score. Raw scores are then interpreted by comparing them to the performance of other students of the same chronological age group by means of so-called 'normative scores'.

The analysis of raw scores plus the age of the students, in the context of large cohorts of students, results in a series of 'normative scores'. Three types of normative score are provided to interpret students' performance on *CAT4*:

- Standard Age Scores (SAS)
- National Percentile Rank
- Stanines

Further information about *CAT4* scores and their interpretation is given in the section entitled 'Guidance on scoring and reporting results' in this document.

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ADMINISTRATION INSTRUCTIONS

CAT4®

COGNITIVE ABILITIES TEST

In this section

CAT4: Step-by-Step

1. **Place order for *CAT4***
2. **Initial 'welcome' email sent (this contains the school's account details/Customer ID which may be used as part of the login).**
3. **Administrator sets password.**
4. **Administrator imports students into Testwise and creates a sitting for *CAT4*.**
5. **Administrator arranges testing, preferably over three sessions.**
6. **First and subsequent test sessions – students are given their access codes to take them directly to the test.**
7. **All testing completed.**
8. **Administrator logs on and generates reports.**

Administering *CAT4*

The administrator will need to read through the following instructions well in advance of the test session and refer to this manual for details of how to import student details.

The information in this manual is a basic guide to administering this test. Further help and information can be found at:

https://support.gl-assessment.co.uk/testwise/gettingstarted

Time needed for testing: levels A to G

CAT4 levels A to G consist of eight short tests. The administration of the digital tests is in three parts, with the Quantitative Reasoning tests split between Part 2 and Part 3. Test timings (which are fixed) are given in the table below, together with an approximation of the time needed for instructions, examples and practice items.

Rough paper and pencil may be used for the Number Analogies and Number Series tests.

***CAT4* Digital**	**Test time***	**Approximate time needed for instructions, examples and practice items**	**Approximate length of test session**
Part 1			
Figure Classification	10 minutes	5 minutes	30 minutes + settling time
Figure Matrices	10 minutes	5 minutes	
Part 2			
Verbal Classification	8 minutes	5 minutes	41 minutes + settling time
Verbal Analogies	8 minutes	5 minutes	
Number Analogies	10 minutes	5 minutes	
Part 3			
Number Series	8 minutes	5 minutes	41 minutes + settling time
Figure Analysis	9 minutes	5 minutes	
Figure Recognition	9 minutes	5 minutes	

*A timer appears on screen and counts down from the time allocated to each test. This cannot be over-ridden as the tests in *CAT4* are strictly timed. If a student does not reach the end of the test in the given time, the test will time out and the student will be moved to the next section or will exit the test.

Time needed for testing: levels X and Pre-A

CAT4 for the younger years consists of four tests one per battery rather than two per battery as per levels A to G. The administration of the digital tests is in two parts. Test timings (which are fixed) are given below.

***CAT4* Digital Level X**	**Test time**	**Approximate time needed for instructions, examples and practice items**	**Approximate length of test session**
Part 1			
Figures	12 minutes	5 minutes	32 minutes + setting time
Words	10 minutes	5 minutes	
Part 2			
Numbers	10 minutes	5 minutes	31 minutes + setting time
Shapes	11 minutes	5 minutes	
***CAT4* Digital Level Pre-A**			
Part 1			
Figure Classification	10 minutes	5 minutes	30 minutes + setting time
Verbal Classification	10 minutes	5 minutes	
Part 2			
Number Series	8 minutes	5 minutes	27 minutes + setting time
Figure Recognition	9 minutes	5 minutes	

Test environment

The test must be administered in a formal test environment with students made aware that they are taking a test and that the usual expectations of behaviour and constraints of a test session will be in place.
It is important that the invigilator is active in ensuring that students are working their way through the tests with intent and that there is no talking or opportunity to copy from another's work.

Checklist for testing

Before the test session

- Check minimum system requirements to ensure system compatibility. Please see requirements at the following link: https://support.gl-assessment.co.uk/testwise/msr
- Allow approximately 40 minutes of testing time for each part of *CAT4* (dependent on the level being taken).
- Provide computer, headphones and a mouse, or a tablet or laptop, fully charged and in good working order for each student.
- Become familiar with these administration instructions.

- Provide rough paper and pencil for the Number Analogies and Number Series tests.

General arrangements for testing

- Be sure the testing room is comfortable.
- Place a 'Testing – Do Not Disturb' sign on the door.
- Try to forestall any interruption of the testing session by visitors or announcements.
- You may want to set up the computers in advance.

Ensure all students are comfortable and prepared before beginning the test.

Introducing *CAT4*

The following wording may be used when introducing *CAT4* to the students:

Today you are going to take some short reasoning tests. All instructions are given on screen and via the audio and you should read carefully to make sure that you understand exactly what you have to do. There will be an example and some practice questions for each test, so read carefully and work through these before starting each test.

Students must work in silence but, if they have a query, they should raise their hand and wait for the teacher to approach them. Answer any questions at this stage and explain that you cannot help with any of the test questions.

All directions, examples and practice items are part of the test and are delivered on screen.

While the students are taking the test the teacher should walk around to check that they are progressing appropriately, that they are not having difficulty with the methods of answering and, importantly with digital tests, that they have not rushed through any part of the test without attempting to answer each question.

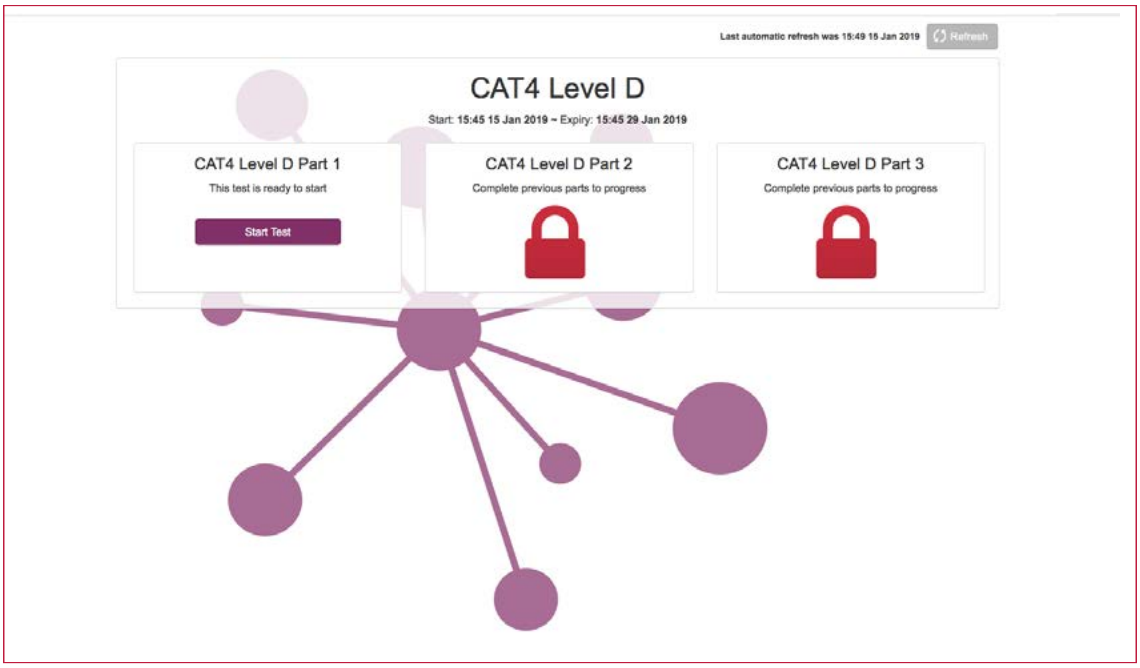
It is possible to keep the Testwise register open on the teacher's machine and thereby track progress through the test. The register shows real time information about whether a student is logged on, has started or completed a test or part of *CAT4* and what is 'in progress'.

Accessing *CAT4*

To access your account you will need to add your school's Customer ID which will have been sent to you in an initial 'welcome' email confirming arrangements for *CAT4* testing.

Students will access the test via www.testingforschools.com/code.

Students need to type in their access code on their own screen. Further information and guidance is given here



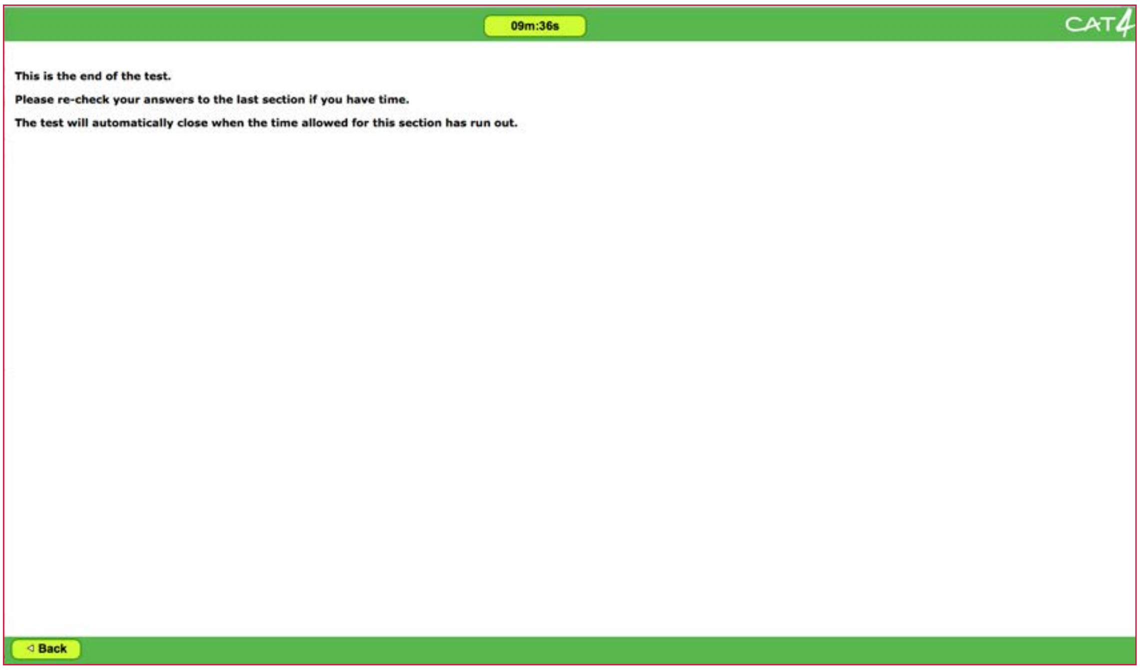
The order in which *CAT4* is taken is fixed and so students must work through Parts 1 to 3 in order.

It is possible to take a break between parts. Testing can be completed over one, two or three sessions and may be carried out over one, two or even three days.

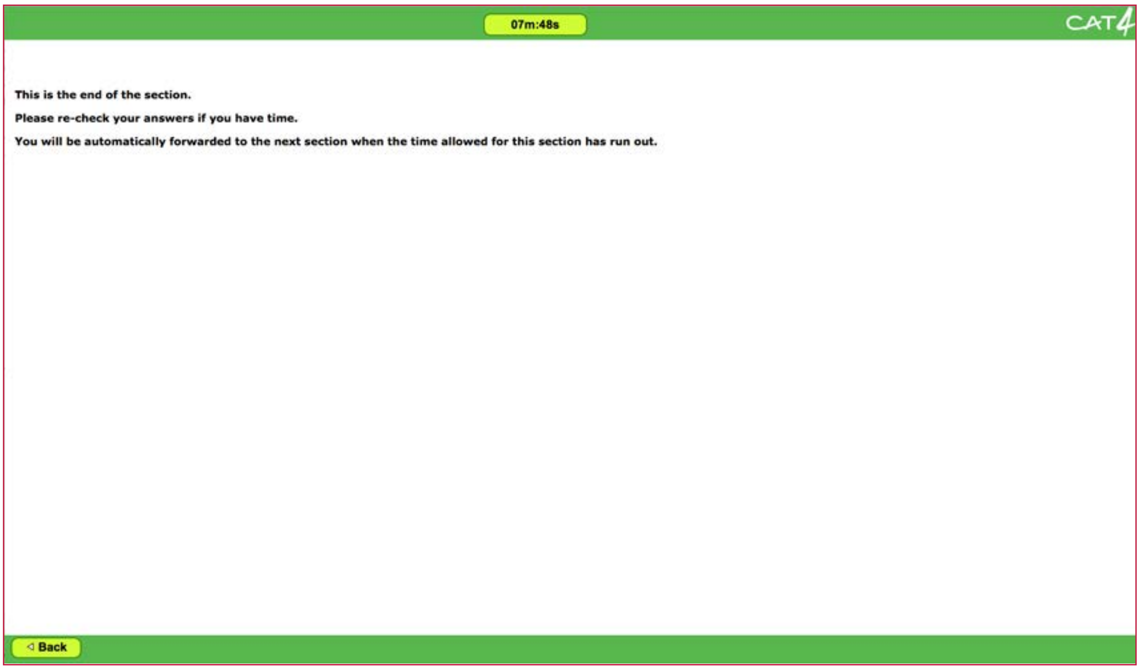
If completing the testing over one day, at least a five minute break between each pair of the three successive parts should help to refresh students.

Students must complete all tests and parts; if they exit the test mid-way through one part of the test their data will be lost. Each test is timed and students will not be able to move to the next until the time is up.

At the end of each test the following screen will appear:



At the end of each part the following screen will appear:



End of test

When all parts of *CAT4* have been completed and the test timer has run out, your results are sent to Testwise.

Students must wait until the time for the final test has elapsed and their results will be stored automatically. Students must not try to exit the test or close the screen by clicking on the cross at the top right-hand corner as this will cause results to be lost.

Technical support

If you have any problems using Testwise, email the Testwise Technical Support Team at support@gl-assessment.co.uk.

You can view our full Testwise Support Services on our website: https://support.gl-assessment.co.uk/testwise/

GL Education®

GUIDANCE ON SCORING AND REPORTING RESULTS

CAT4®

COGNITIVE ABILITIES TEST

In this section

Using *CAT4* for the benefit of students

CAT4 has become established over many years as a reliable and informative assessment of students' developed abilities. Results from *CAT4* can help in intervention, monitoring progress and setting targets for future attainment.

CAT4 'unlocks potential'.

Many teachers tell us that *CAT4* is unique in the way it can 'unlock potential' – that is, identify a student with high level ability who may have been overlooked or who is in danger of underachieving. *CAT4* has become recognised in the assessment of gifted students and is used by numerous schools to identify such students, many of whom may not be among the top sets, who need extra challenge in their schoolwork. These are just two of the varied uses of *CAT4*.

The information the test yields can become a reference point against which progress and performance can be measured. It is desirable to test students more than once as their abilities develop and their profile may well change over time.

The more we know about an individual, the better position we should be in to offer a learning environment and ways of teaching and learning that allow individuals to maximise their potential. Information about a student's reasoning ability will be key to many decisions and should be considered alongside attainment data and other factors known to impact on learning, such as attendance and attitude. The results from *CAT4* provide evidence of a student's present level of development in reasoning. So the pattern of scores will reveal particular strengths or weaknesses, plus a comparison with previous scores from a lower level of *CAT4* will give an insight into the student's development.[1]

[1] Increased scores at the second point of testing will indicate how much the student's ability has developed, and an increase in the Standard Age Score (*SAS*) of 10 points or more can be considered significant. Static scores, for example getting the same score on a particular battery in *CAT4* Level B and again in Level D two years later, tell us that the student's ability has developed at an average rate.

When to test with *CAT4*

When *CAT4* is administered will vary according to each school's calendar and the purpose for which the results will be used.

Primary schools will most likely administer *CAT4X* and Pre-A, A, B or C during term 1 so that the diagnostic information can be used to modify, as necessary, the educational programme of an individual student or groups of students.

It should be remembered that the most accurate comparison with the UK (National Average) will occur when *CAT4* is administered between September and November, since that was when the standardisation of *CAT4* was carried out.

CAT4 is commonly administered at the start of the secondary/high school education phase. Later use of *CAT4* will be linked to the timing of particular decisions taken in the secondary school, such as the setting of end of key stage targets or the choice of appropriate examination or pre-vocational courses. Career guidance can also be greatly assisted by knowing a student's profile of abilities as revealed by *CAT4* results.

Some schools, however, will see greater advantage in choosing the second term as a compromise between assessing what has happened and deciding what is likely to happen. There is still time to take action over weaknesses revealed by the testing.

At any time of the year the new entrant to, or late transfer from, a school can be quickly and reliably assessed with the help of *CAT4*.

Scoring *CAT4*

The *CAT4* is scored automatically on completion of the tests. Teachers and administrators can access reports through their school's online account and reports can be generated on demand. For details of GL Education's online scoring and reporting via Testwise, please see the Testwise manual in the Help section:
https://support.gl-assessment.co.uk/testwise/reports

Example of register

Below is an example of a spreadsheet ready for upload to the register.

First Name *	Last Name *	Unique Identifier *	Date of birth *	Gender *	Group *	Year	Free School Meals	Ethnic Group	SEN	English as a Second Language	Custom 1	Custom 2
Jaimin	Shah	12345	01/01/1998	Female	Class 8A	8	Yes	Asian or Asian British	Communication problems	Yes	01Shah	Jaimin.Shah@glcollege.com
Reah	Patel	23456	02/01/1998	Female	Class 8B	8	No	Asian or Asian British - Bangladeshi	Learning difficulties	No	02Patel	Reah.Patel@glcollege.com
Olivia	Singh	34567	03/01/1998	Female	Class 8A	8	No	Asian or Asian British - Indian	Medical or health conditions	Yes	03Singh	Olivia.Singh@glcollege.com
Jalal	Simpson	45678	04/01/1998	Male	Class 8C	8	No	Asian or Asian British - Pakistani	Sensory or physical needs - hearing impairment	No	04Simpson	Jalal.Simpson@glcollege.com
Lindsay	Parsons	56789	05/01/1998	Female	Class 8C	8	No	Asian or Asian British - any other Asian background	Sensory or physical needs - physical difficulties	No	05Parsons	Lindsay.Parsons@glcollege.com
Lisa	Payne	67891	06/01/1998	Female	Class 8A	8	Yes	Black or Black British	Sensory or physical needs - visual impairment	No	06Payne	Lisa.Payne@glcollege.com
Jalal	Simpson	78912	07/01/1998	Male	Class 8B	8	No	Black or Black British - African	Social, emotional or mental health difficulties	No	07Simpson	Jalal.Simpson@glcollege.com
James	Scott	89123	08/01/1998	Male	Class 8B	8	No	Black or Black British - Caribbean	Specific learning difficulty with number work	No	08Scott	James.Scott@glcollege.com
Jamie	Sherwood	91234	09/01/1998	Male	Class 8B	8	Yes	Black or Black British - any other Black background	Specific learning difficulty with reading	No	09Sherwood	Jamie.Sherwood@glcollege.com
Jean	Kim	101850	10/01/1998	Female	Class 8C	8	No	Chinese	Specific learning difficulty with understanding information	No	10Kim	Jean.Kim@glcollege.com
Theo	Allen	109874	11/01/1998	Male	Class 8C	8	No	Gypsy/Roma	Specific learning difficulty with writing	No	11Allen	Theo.Allen@glcollege.com
Matthew	Bateman	119626	12/01/1998	Male	Class 8A	8	No	Mixed	None	No	12Bateman	Matthew.Bateman@glcollege.com

Getting the data analysis right

This section helps you ensure that the analysis of *CAT4* results will meet the needs of your students and your school.

Testing platform

Ensure that data supplied to GL Education is as accurate as possible: the 'cleaner' the data is, the more meaningful the reports are likely to be.

Tests will be taken on Testwise, a platform for administering our digital tests. When adding students to the Testwise register, certain pieces of information are mandatory. These are:

- Unique identifier
- First name
- Last name
- Group (this should be the teaching group or tutor group rather than the year group as it will allow additional analysis by the teacher)
- Date of birth
- Gender

For further help and information, view our full Testwise Support Services on our website:

https://support.gl-assessment.co.uk/testwise/

Most schools will be able to export these details for a pre-determined group from the school's management information system.

If additional analysis is required, the following categories have been pre-programmed:

- Year (group)
- External reference
- Ethnicity (international schools to use Nationality)
- Special educational needs
- English as an additional language

The analysis for these categories (excluding the external reference) will be limited to a graphical display showing up to five different groups and a table including up to 20 different groups.

Note that if no entry is given for a student, Testwise processes this as 'Unknown'. This 'Unknown' category will count as one of the groups for graphical display so it is recommended that wherever possible an entry is given for each category for each student. If more than 20 groups are defined, Testwise will report on the 20 most frequent and will classify the remainder as 'Other'.

To get the best from the analysis it is strongly recommended that you limit the information as follows:

- Year – include the year group for the individual student
- External reference – this may be used to allocate an internal unique identifier for the students
- Nationality
- Special educational needs – indicate 'yes' or 'no'
- English as an additional language – indicate 'yes' or 'no'

There are two further categories which you can customise according to your requirements. These are called 'Custom 1' and 'Custom 2'. Suggestions for additional student-level information that could be included under Customs 1 or 2 are:

- First language (again, limiting these to the 'top 20' spoken in school will make analysis more meaningful).
- Additional learning needs breakdown. If your school has special provision for children on the autistic spectrum or with speech and language disorders, for example, these categories could be highlighted. Again, it is recommended that only the 20 most common additional needs or fewer are included.

As the reports will cut off text entries in a cell after 65 characters, it is recommended that entries for fields are kept as succinct as possible, whilst still being meaningful.

What *CAT4* tells you

The four batteries of *CAT4* assess a student's ability to reason with different kinds of material and so provide information that is highly valuable for both understanding students' strengths and diagnosing their learning needs.

What the four batteries assess

The Verbal Reasoning Battery assesses reasoning ability with words representing objects or concepts. The tests in this battery do not focus on the physical properties of the words themselves, such as the alphabetical position of their first letters. Likewise, the Quantitative Reasoning Battery assesses reasoning with numbers, with the numbers representing the relevant numerical concept, rather than being used for their physical properties such as whether they consist of two digits or one. The Nonverbal Reasoning and Spatial Ability Batteries are somewhat different in that the shapes themselves are the focus of the assessment rather than the shapes symbolising something else.

Thinking with words

The Verbal Reasoning Battery necessarily requires some reading ability. However, *CAT4* limits the reading requirements to a modest level throughout. The vocabulary demands of the Verbal Analogies and Verbal Classification tests have been kept as low as possible. Also, the background knowledge needed to answer the verbal questions is that which all students will have encountered in school or everyday life, rather than including topics that may only be familiar to certain socio-economic or cultural groups.

Vocabulary demands and the need for background knowledge have been kept to a minimum in the Verbal Reasoning Battery.

Consequently, scores on the Verbal Reasoning Battery will usually reflect students' ability to use words as a medium of thought. The exceptions will be when students have poor reading skills or where English is not a student's first language.

It is also worth noting that all the instructions for the *CAT4* batteries are presented orally to students, so any influence of reading skills is limited solely to the items in the Verbal Reasoning Battery.

Thinking with numbers

The Quantitative Reasoning Battery has been designed to be minimally reliant on mathematical knowledge. The Number Analogies test requires only basic arithmetical knowledge, and parallels the analogy tests in the Verbal and Nonverbal Reasoning Batteries. The Number Series test focuses as far as possible on the identification of relationships between the elements of the questions, though basic arithmetical knowledge is necessarily required too.

Mathematical knowledge is kept to a minimum in the Quantitative Reasoning Battery, although basic arithmetic is needed.

In this way, the Quantitative Reasoning Battery will give a genuine indication of most students' ability to think with numbers, with the exception of children with particularly low arithmetic skills.

Thinking with shapes

The Nonverbal Reasoning Battery assesses the ability to think and reason with nonverbal material, that is to analyse figures made up of multiple elements, identify the relationships between these elements and identify further examples of these relationships. The Figure Matrices test parallels the analogies tests in the Verbal and Quantitative Reasoning Batteries. The Figure Classification test requires the identification of common elements between figures and parallels the Verbal Classification test.

The Nonverbal Reasoning Battery does not rely on high level verbal skills or English.

Consequently, the Nonverbal Reasoning Battery reveals how well students can think when working with shapes. As these questions do not necessarily rely on highly developed verbal skills or the use of English for their solution, they can provide insight into the reasoning abilities of students with poor verbal skills or who are not particularly fluent in English.

Thinking about shape and space

The Spatial Ability Battery assesses the ability to think in spatial terms, that is to visualise shapes and objects and the effects of manipulations on these. The Figure Analysis test requires the student to imagine the effect of a series of physical manipulations on a square of paper. This test relies on both spatial and reasoning abilities, such as recognising that, if a hole is made through layers of a doubled-over sheet, there must be two holes when the sheet is unfolded. The Figure Recognition test requires the identification of a target shape within a complex design, so assessing the ability to identify a remembered shape from within more complex information.

Students with a high spatial ability may be well-suited to jobs involving visual mapping such as architecture, graphic design, photography and astronomy.

As spatial tests make no demands on verbal ability, they can be highly effective indicators of potential in students with poor verbal skills, as well as effectively identifying the weaker abilities of those who have verbal strengths. This then provides a more comprehensive picture of the students concerned.

Scores from *CAT4*

For each *CAT4* test students obtain a raw score which indicates the number of questions they answered correctly.

These raw scores are interpreted by comparing them to the performance of other students of the same chronological age group using what are referred to as ‘normative scores’. Three types of normative score are provided for the interpretation of performance: Standard Age Scores (*SAS*); National Percentile Rank (*NPR*) by age; and stanines (*ST*) by age.

For further information on these normative scores please see p.17.

- **Standard Age Scores (*SAS*):** These are presented on a standardised score scale where the average for each age group is set to 100 and the standard deviation set to 15.[2] This means that a student who gains the same *SAS* on two different batteries has done equally well on both, compared to others of the same age. It also means that students of different ages who have the same *SAS* have done equally well when judged in relation to others of their own age.
- **National Percentile Rank (*NPR*):** This indicates the proportion of students of the same age who have scored the same as or below the student in question. For example, a student who achieves a percentile rank of 84 has scored equal to or better than 84% of students in the same age band; only approximately 16% of students achieved a higher score on this test.
- **Stanines (*ST*):** This is a standardised score scale divided into nine bands. In a stanine scale the scores are grouped as shown in the table below. Stanines are particularly useful when reporting test results to students and parents as they are relatively easy to understand and interpret. They also avoid the erroneous impression of being 'IQ scores', sometimes attributed to *SAS*.

The stanine scale

	Stanine	Percentage of cases	Corresponding percentiles	Corresponding *SAS*
Very high	9	4%	97 and above	127 and above
Above average	8	7%	90–96	119–126
	7	12%	78–89	112–118
Average	6	17%	59–77	104–111
	5	20%	41–58	97–103
	4	17%	23–40	89–96
Below average	3	12%	12–22	82–88
	2	7%	5–11	74–81
Very low	1	4%	4 and below	73 and below

In order to understand the difference between *CAT4* Level X standard age score reporting and the other *CAT4* levels please see further guidance at: www.gl-education.com/content-pages/cat4-x/

[2] This means that approximately 68% of students in the norm group for that age scored between 85 and 115, approximately 95% scored between 70 and 130, and over 99% scored between 60 and 140, the limits of the *CAT4 SAS*.

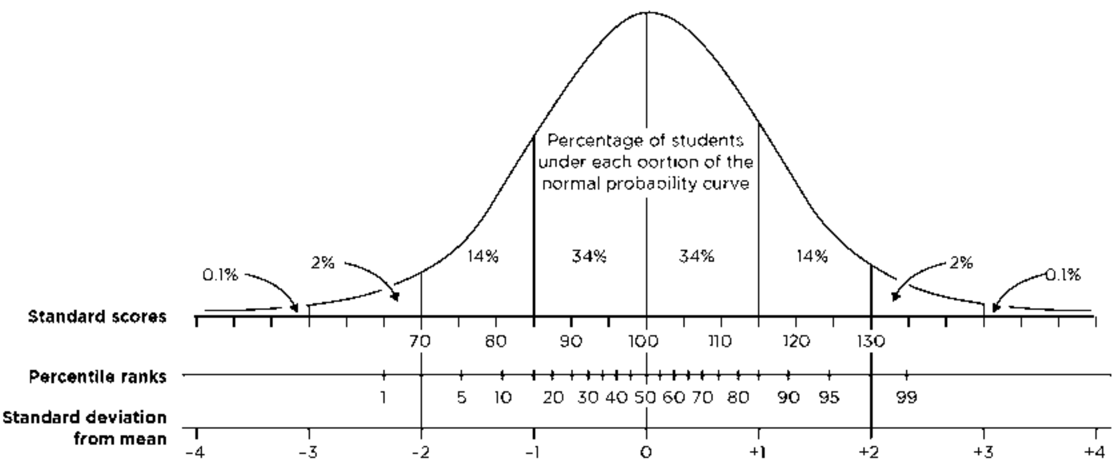
Relationship between *CAT4* scores

The relationship between the three types of normative score is shown below, along with the normal distribution curve which illustrates the distribution of test performance in each age range.

Figure 1: Relationship between scores

Description	Very Low	Below Average	Average	Above Average	Very High
Stanine (ST)	1	2, 3	4, 5, 6	7, 8	9
Standard Age Score (SAS)	70	80, 90	100, 110	120	130
National Percentile Rank (NPR)	1, 5	10, 20	30, 40, 50, 60, 70	80, 90	95, 99

Figure 2: Normal distribution curve



Low or unreliable scores

If a student's score on any one of the batteries is very low, it should be regarded with caution.

Before interpreting an individual student's score on any of the *CAT4* reports, scan the report and find the number of questions attempted. This will show if a student has left a large number of questions unanswered on any of the batteries, or if his or her score is close to that expected from random guessing.

Examples of low and potentially unreliable scores are illustrated in the case studies found in this document.

If all or nearly all of the questions have been attempted, then random guessing will result in raw scores at the 'chance level' shown in the table below. If fewer questions have been attempted then random guessing will, on average, result in a raw score of around one-fifth of the number of questions attempted.

This table shows chance levels of performance and these should be used to identify any students whose scores should be looked at more closely.

If the raw score is the same as or lower than the chance level given for the battery, then caution should be exercised in interpreting the score.

Chance levels of performance on *CAT4* batteries		
	Maximum raw score	**Chance raw score**
Verbal Reasoning Battery	48	10
Quantitative Reasoning Battery	36	7
Nonverbal Reasoning Battery	48	10
Spatial Ability Battery	36	7

Any student who omits a large number of questions, or answers most of the questions but gets few of them right, is probably functioning at a low level in the cognitive area being tested. In either case, the student's score cannot be relied upon with confidence. Although these scores might actually represent the true level of the student's abilities at the time of testing, a better view of what the student can do might be obtained by retesting with *CAT4* after a gap of at least six months – consider assessing the student with a series of tests that look at ability, processing and attainment, which might point to a specific learning difficulty; or seek outside support from an educational psychologist who can carry out a specialist assessment.

CAT4 reports

A range of *CAT4* reports has been developed following extensive market research and feedback to ensure that new reports are clearly focused on specific audiences.

Report	Summary of contents
Group report for teachers	• A description of the assessment, overview of its benefits, example questions and a useful reminder of how scores are reported • Table of scores for all students in your group, showing the *SAS* and group ranking for each battery plus overall mean scores • Analysis of your group scores compared to the UK national average • Profile chart and listings indicating the learning preferences for all students in your group, with supporting explanation • Indicators of future attainment in UK national tests/examinations
Individual student report for teachers	• A description of the assessment, overview of its benefits, example questions and a useful reminder of how scores are reported • Detailed breakdown of scores for each student, including the *SAS*, with confidence bands, National Percentile Rank, stanines and group ranking • Profile description for each student indicating their learning preference, with written implications for teaching and learning also given, which help to ensure a student achieves their potential • Indicators of future attainment in UK national tests/examinations
Individual report for students	• An explanation of the assessment, overview of why it is used and benefits for students • Student-friendly overview of performance scores across the four batteries • Profile description with written recommendations to help improve student understanding and support effective learning • Indicators of future attainment in UK national tests/examinations with supporting chart for ease of comparison across subject areas
Individual report for parents	• An explanation of the assessment, overview of why it is used and example questions to ensure parents are informed • Parent-friendly overview of performance scores across the four batteries • Profile description with written recommendations to help improve parent understanding of their child's learning preference, with suggestions for how to offer support at home • Indicators of future attainment in UK national tests/examinations with supporting chart for ease of comparison across subject areas
Summary report for senior leaders	• A description of the assessment, overview of its benefits and a useful reminder of how scores are reported • Detailed analysis of your cohort/group scores compared to the national average, with analysis by battery, gender and ethnicity, and further options available as specified • Profile chart indicating the learning preferences for all students in the cohort/group, with supporting explanation • Summary indicators of future attainment for the full cohort/group • Note, a Summary presentation for senior leaders is also available in PowerPoint® format, ideal for sharing key findings with a wider audience

A CSV or Excel report which gives all raw/core data is available and will enable further analysis of results. A cluster report is available, based on the Summary report for senior leaders, which brings together the results from more than one school or a group of schools, as required.

Further reports are under development and will include those to help teachers working with students with additional needs or with very able students, as well as subject leaders. As soon as these reports are available, samples will be posted on the *CAT4* website.

Schools that use both our ability and attainment assessments can have access to a free report that compares their attainment data to the ability data from the *Cognitive Abilities Test (CAT4)*. Our ability test plays a vital role when trying to identify underachievers, or those not fulfilling their potential, and when combined with attainment data and professional teacher judgement, it provides a well-rounded picture of each individual student.

The *CAT4* Combination report takes data on pupil ability from the *Cognitive Abilities Test, 4th Edition (CAT4)* and on attainment from the *Progress Test in Maths (PTM)* and *Progress Test in English (PTE)*. It can also include data on reading from the *New Group Reading Test (NGRT)*, as an alternative to *Progress Test in English*. A number of test combinations are possible (see below), but *CAT4* is always present, acting as an 'anchor' for the report.

Test Combination	**CAT4 ability scores used for comparison**	**Attainment being compared**
CAT4 + PTM	Quantitative Reasoning	Maths attainment
CAT4 + PTE	Verbal Reasoning	English attainment
CAT4 + NGRT	Verbal Reasoning	Reading attainment
CAT4 + PTM + PTE	Quantitative Reasoning Verbal Reasoning	Maths attainment English attainment
CAT4 + PTM + NGRT	Quantitative Reasoning Verbal Reasoning	Maths attainment English attainment

What do I get out of the *CAT4* Combination report?

By comparing these results, attainment is seen in the context of each student's ability and potential. With this you can identify:

- Potential underachievers
- Where attainment is broadly in line with ability
- Where pupils appear to be attaining at a level that is higher than their potential suggests
- Potential SEN and underpin intervention with these test data and comparing them with the school's own information and knowledge of a student.

What can I do with the data?

- Correlate students' performance in CAT – specifically the verbal reasoning and quantitative reasoning batteries – with attainment demonstrated through PTM, PTE and/or NGRT
- Identify whether the relationship between ability and attainment is as expected or whether there is a significant divergence in scores which may need further investigation
- Compare performance using the national benchmark – standard age score – which allows for accurate comparisons to be made across different tests
- Deepen the understanding of your pupils' current and potential performance; enhancing a 'whole pupil view' of each child
- Compare pupils with the national average for their age.

The *CAT4* student profile

CAT4 is a profile of a student's learning bias or preference based on a comparison of scores obtained on the Verbal Reasoning and Spatial Ability Batteries.

What is shown may not be a preference or bias that is observed or used in the classroom. Rather it suggests an underlying bias towards learning in a particular way or a way that combines different skills, which draws on strengths demonstrated in results from *CAT4*.

Verbal and spatial abilities may be seen as extremes on a continuum of ability (with numerical and nonverbal abilities representing a combination of these two extremes in differing degrees). The *CAT4* profile contrasts the extremes using the stanine score as the most relevant measure and factors in the level of ability displayed in each area.

This results in a profile for each student in one of the following seven categories:

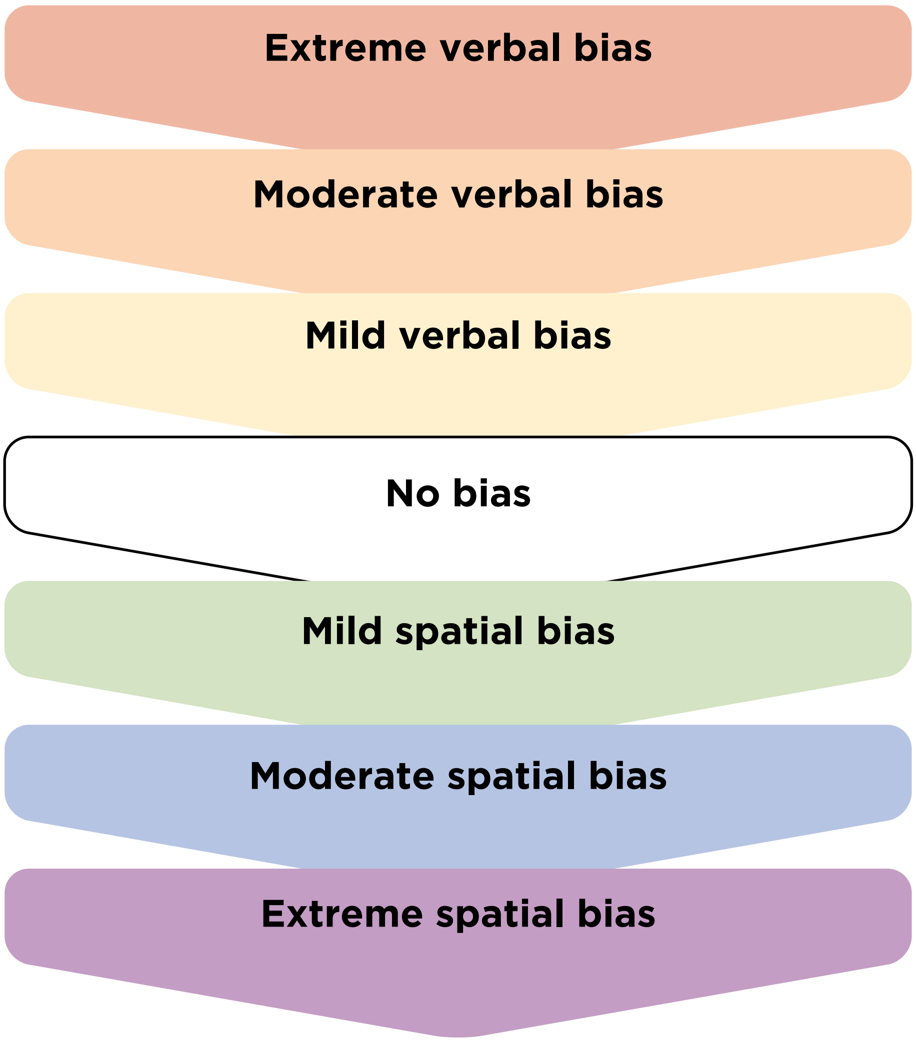
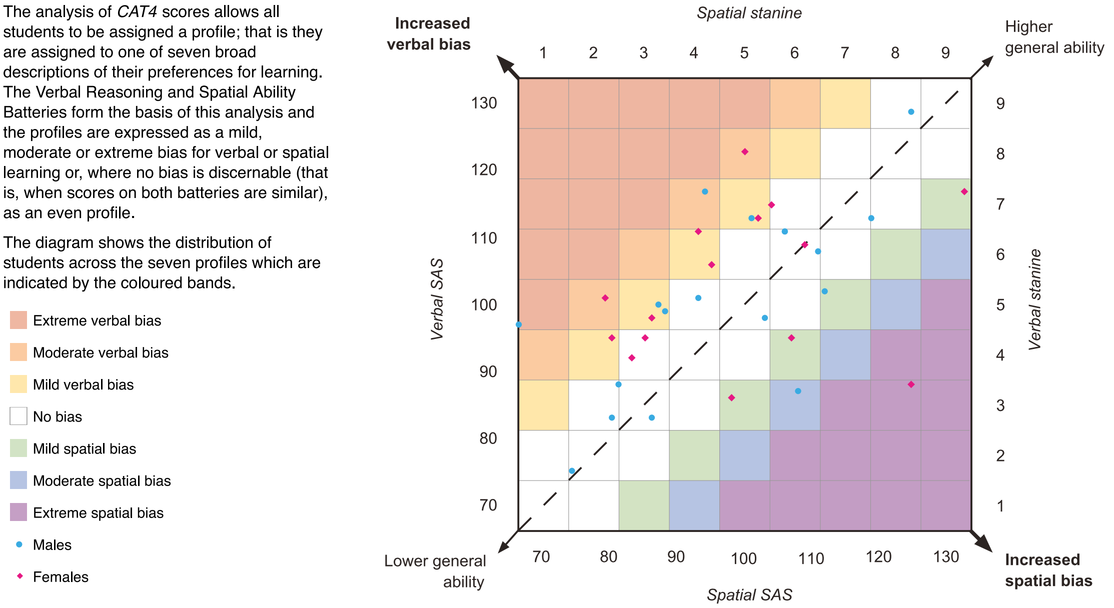


Figure 3: Student profiles (from Group report for teachers)

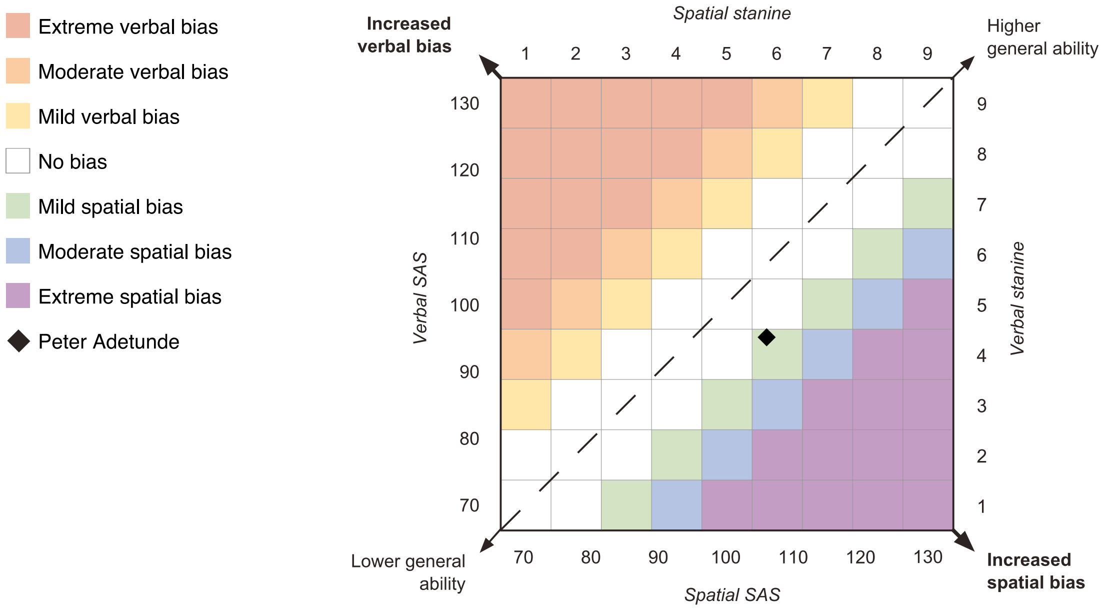
The analysis of *CAT4* scores allows all students to be assigned a profile; that is they are assigned to one of seven broad descriptions of their preferences for learning. The Verbal Reasoning and Spatial Ability Batteries form the basis of this analysis and the profiles are expressed as a mild, moderate or extreme bias for verbal or spatial learning or, where no bias is discernable (that is, when scores on both batteries are similar), as an even profile.

The diagram shows the distribution of students across the seven profiles which are indicated by the coloured bands.



In Figure 3, extracted from the Group report for teachers, each student is plotted on a colour-coded grid to show the distribution for the group across the seven categories. Some of your students may be in the 'no bias' category. Ability is indicated by the line from lower to higher ability that transects the grid, so that level of ability as well as profile type is shown. There follows a listing of students in each profile category and a brief description of each category (see Figure 7 for an example of this).

Figure 4: Student profile (from Individual student report for teachers)



In Figure 4, extracted from the Individual student report for teachers, the student's profile is plotted on the grid as an immediate visual aid to assessing both level of ability and profile type. This is followed by a more detailed narrative analysis of the profile and some implications for teaching and learning. Both these narratives take into account both the balance of the profile (that is the relative strengths and weaknesses demonstrated by scores from the Verbal Reasoning and Spatial Ability Batteries) and the level of ability.

For a student to be included in the group analysis by profile category and to receive the graphical and narrative sections of the Individual student report for teachers, both the Verbal Reasoning and Spatial Ability Batteries must be administered. Likewise, the Individual report for students and Individual report for parents will be cut short and compromised if these parts of *CAT4* have been omitted.

It is important to review all four battery scores of each student, as a suppressed verbal reasoning score due to EAL may lead to the student appearing to have a strong spatial bias. This would be accurate information at the time of taking the *CAT4* assessment, but a situation that may change over time as development of the student's English language skills occurs.

Communicating *CAT4* results

Teachers have told us that it is often difficult to find the time and opportunity to explain *CAT4* results to teaching colleagues. They fear this may seem burdensome or imply that additional work needs to be done. The development of reports for *CAT4*, including the individual narrative, makes this process easier and enables teachers and students to benefit from the additional information and recommendations arising from the testing process.

Students, parents, governors and other professionals involved in supporting children may also find an understanding of *CAT4* results helpful.

However, the use of reports can be further enhanced by knowledgeable users discussing *CAT4* results and, in doing so, ensuring that the key messages are tailored to the audience so that everyone has a clear understanding of the results and their implications.

Successful communication of *CAT4* results has a number of common elements, whatever the audience. These are outlined below.

Build on existing knowledge and understanding

For communication to be successful it must build on the listener's current understanding of assessment generally and *CAT4* results in particular. Although it may be true that teachers and other educational professionals will, on average, have a greater understanding of assessment than other groups such as parents, this will not always be the case. Some teachers, especially if new to the profession, may have a limited understanding of assessment, whereas some parents, for example, may be extremely knowledgeable. The key point is that communication must be tailored to the recipient's current level of understanding of *CAT4*, and so it should not be assumed that certain groups will have sufficient understanding whereas others will not. Always check out the particular person's understanding before communicating results.

Sometimes it may be necessary to give a brief explanation of *CAT4* and its use before results can be meaningfully understood and applied. A brief introductory text has been added to many of the *CAT4* reports to help with this. Such an explanation may be needed during a discussion of results with an individual or small group.

Information about CAT4 can be found on the GL Education website: https://support.gl-education.com/knowledge-base/assessments/cat4-support/about-cat4/general-information-cat4/.

If results are regularly used across a whole school in a way that has a marked impact on teaching and learning, it will be important for all recipients of results to have a good working knowledge of *CAT4*. Under these circumstances it may be appropriate to provide whole-school briefings.

Clear and appropriate communication

Having established the recipients' level of understanding, information must be communicated clearly and succinctly, in a way that builds on their current level of knowledge. Consider how communication will take place – in writing, orally or a combination of the two – and what support may be needed for this to be effective.

CAT4 reports include combinations of visual, numerical and textual information. It is likely that certain elements of the reports will appeal to, and be more readily understood by, some people more than others. For example, some people will instantly pick up meaning from a graph but may struggle to make sense of the table of data on which the graph is based. As a communicator, varying the style in which you convey test results, by building on what listeners find most intuitive and using this to support understanding of those areas that are less intuitive, is a valuable skill.

A further point to consider is the amount of information that it is necessary to convey. The *CAT4* reports have been developed for particular purposes and so contain selected information considered to be most appropriate for those purposes. So, detailed group reports may contain more information than is needed for some purposes. In these cases, match the information to the listeners' needs and make sure that it is communicated clearly. Where more detailed reports are being used, point out what information should be of most use to them and make sure they know how to interpret it.

Checking understanding and clarifying actions

It is important to ensure that communication is a genuine dialogue. Particularly when new to *CAT4* results, recipients are likely to have many questions and need the opportunity to absorb the information and ask their questions. Some people may need time to understand fully the implications of *CAT4* results and consider what they mean in terms of teaching and support for individual students, classes or whole year groups.

It is useful to check understanding and clarify actions after communicating results. Listening carefully to the recipients' understanding of what they have heard is a good way of checking that information has been understood. Opportunities for follow-up and further discussion of *CAT4* results may also be necessary. Implementing results may lead to further questions and the wish to explore applications of *CAT4* in more depth.

Communicating *CAT4* results to specific groups

Communicating results to students

CAT4 is a test for which students do not need to prepare. It is important that the test sessions should be an integral part of the timetable to avoid undue anxiety in students. Older students may want to know what *CAT4* is about. It is a well-known test and there may be misinformation circulating about why students are being tested and how results are used. A short explanation – that *CAT4* is an assessment of ability in four different areas and has no direct connection to the curriculum, so it cannot be prepared for – and reassurance that results will be used to understand better how students learn will help to put students' minds at rest.

Whatever their scores, it is important for all students to understand that the information gained from *CAT4* testing can form the basis of plans for their future development, which they themselves can take some control over. No matter what the outcomes of the *CAT4* tests, students should be encouraged to think positively about their results. Instead of reporting normative scores, reports about individual students present the student's relative performance on the four *CAT4* batteries. Scores on the four batteries are presented so students can see in which of the four reasoning areas they are strongest or weakest. This style of reporting is used for all students, no matter what their normative scores and overall level of reasoning ability. These reports also include additional narrative describing their profile and giving them ideas to further their learning according to the scores obtained.

It is recommended that relative strengths and weaknesses are presented, followed by a discussion with the student.

Therefore, it is recommended that this approach of presenting relative strengths and weaknesses is also followed when discussing results with students. Students, no matter what their overall level of performance on *CAT4*, should be clear about their areas of strength and supported in understanding how they can build on these. This is not to say that areas of weakness should be downplayed. Students should be clear about the areas where they need to develop further and have appropriate expectations about their future performance in school. Students should be encouraged to contribute to their own development targets, being supported as appropriate to set challenging yet attainable targets.

Checking that students have understood their results and the implications of these results is important, particularly for those with lower *CAT4* results. It is essential that every student, whatever their ability, should take some positives away from a discussion of their *CAT4* results.

Communicating results to teachers

In most schools, arranging the *CAT4* testing sessions and reviewing and implementing results will be the responsibility of a single senior teacher or a small team of colleagues.

Successful differentiation will depend on many factors, such as students' motivation, classroom structure, opportunities for personalised support and scaffolding learning. All of these will combine to affect students' learning outcomes.

Raising awareness of the benefits of *CAT4* may not always be straightforward, but we know that teachers want to support students as individuals. *CAT4* is an aid to doing this and need not imply additional workload.

The Group report for teachers will help in communicating results and, importantly, details of learning biases among students in different teaching groups. This may allow those with similar or contrasting profiles to be taught together, with mutual benefits. The narrative that is part of the Individual student report for teachers includes implications for teaching and learning which offer brief insights into how different levels of ability combined with learning preferences may affect a student's learning. It is hoped that simple adjustments based on *CAT4* results and other information about the student can improve outcomes.

One of the main uses of *CAT4* is to help teachers understand the potential and the learning needs of students and so differentiate their teaching methods accordingly. The full pattern of results from *CAT4* needs to be considered, as abilities will work in interaction with each other and not in isolation. Differentiation of teaching methods can then be achieved in a way that draws on students' strengths and, through these, supports weaker areas.

Discussion of *CAT4* results and subsequent targets can help build links between school and home.

Communicating results to parents

Some parents will know about *CAT4* but what they know may be based on misinformation. If the school wishes to inform parents about the *CAT4* testing process, a sample letter can be found in Appendix A as a guide to what might be included. There is also a sample letter for post-testing purposes in Appendix A.

Many parents will naturally be interested in all aspects of their child's performance at school, including their *CAT4* results. The *CAT4* reports have been developed to support the routine reporting of results to parents. As parents play an important role in their child's development outside of school, these reports also include narrative text that will help parents understand their child's profile of results and what they can do to further their learning. The Individual report for parents includes a short description of *CAT4*, results on each battery and indicators of future attainment based on the results. A short description of how these indicators are derived and what they mean has also been included.

As with the communication of results to students, there is no single best or right way of doing this, but it is recommended that the report is discussed with parents rather than simply being sent to them. Even though the reports have been written for a parent audience, discussing results with parents will ensure that the content is understood accurately. The reports can also be used as a focus for further exploration of strengths and learning needs with parents and as a way of engaging parents in actions they can take at home. In this way, *CAT4* can be used as an effective tool for reinforcing school-based learning activities in the home.

Communicating results to other professionals

CAT4 results can be relevant to a range of other professionals who are involved with students' welfare and development. Some colleagues may have a limited knowledge of testing and so the introductory text that forms part of the new reports will be useful in giving a quick overview and an example of the test material in *CAT4*.

Information from any test is most meaningful when it is communicated as part of a broader assessment of a student, rather than in isolation. In any such communication it is important to distinguish between what can be considered as 'fact' and what is 'opinion'. The *CAT4* results provide factual information on the student's level of reasoning ability across the four batteries at the time of testing. Opinions, in this case, are the professional judgements that teachers and others who know the student may make, given an understanding of their *CAT4* results plus other information. Although both facts and opinion can be equally valid, in some circumstances it will be important to make a clear distinction between the two.

Information about reading and other attainments are available.

CAT4 scores of individual students

When communicating the results of individual students, there are further important things to bear in mind.

- *CAT4* results should not be presented in isolation. Test results are a 'snapshot' of performance at one point in time and only give one view of the student's performance. Thorough assessment is a continuous process that draws on many sources of evidence. Results should always be considered in conjunction with reports of attainment in specific subjects and teacher assessments, along with feedback on the engagement, motivation and effort made by the student.
- Any misconceptions of *CAT4* being a measure of fixed ability should be challenged. Like physical abilities, cognitive abilities can be developed through experience and practice. However, having an aptitude for a particular sport will influence performance and, in the same way, a preference for one type of reasoning ability is likely to support greater attainment in that particular area.
- Low *CAT4* scores should never be used to put a ceiling on expectations of what the student can achieve, particularly if the student comes from an economically or socially disadvantaged background which may mean they are not sufficiently familiar with the test content to obtain a reliable assessment of their abilities. Rather, results should be used as the basis for planning activities and a learning programme that is aimed at improving all students' reasoning abilities alongside their attainment in curriculum subjects.

The case studies in this document illustrate the interpretation, communication and application of *CAT4* results.

Sample reports

Figure 5: Scores for the group from Group report for teachers

CAT4 Group report for teachers

CAT4

School: Test School

Group: Year 7

Date of test: 13/09/2019 | **Level:** D | **No. of students:** 60

Scores for the group (by overall mean SAS)

Student name	Tutor group	Verbal			Quantitative			Non-verbal			Spatial			Overall	
		No. attempted (/48)	SAS	GR (/60)	No. attempted (/36)	SAS	GR (/60)	No. attempted (/48)	SAS	GR (/60)	No. attempted (/36)	SAS	GR (/60)	Mean SAS	GR (/60)
Sara Shafiq	EM	48	**130**	1	36	**120**	=3	48	**119**	3	36	**126**	=2	**124**	1
Natasha Aransola	EM	47	**108**	=14	31	**120**	=3	41	**124**	1	36	**120**	=4	**118**	2
Jenny Coyle	MCO	48	**101**	=25	36	**118**	5	48	**115**	=5	36	**131**	1	**116**	=3
Samera Kan	DK	48	**113**	9	34	**116**	6	43	**115**	=5	32	**120**	=4	**116**	=3
Lara Sandford	DK	48	**97**	36	33	**111**	=9	48	**121**	2	36	**126**	=2	**114**	=5
Mia Shimizu	DK	48	**123**	=4	36	**109**	13	43	**103**	=25	36	**120**	=4	**114**	=5
Mia Shimizu	MCO	48	**122**	6	29	**111**	=9	48	**112**	=8	31	**112**	13	**114**	=5
Anthony Jameson	MCO	48	**120**	7	36	**108**	14	48	**106**	=21	36	**118**	7	**113**	8
Paisley McSeveney	MCO	48	**112**	=10	32	**111**	=9	46	**112**	=8	34	**114**	=9	**112**	9
Gabriel Bester	DK	48	**125**	2	20	**98**	=29	37	**101**	30	30	**114**	=9	**110**	=10
Petya Kan	EM	48	**100**	=28	35	**123**	=1	46	**108**	=16	36	**108**	=17	**110**	=10
Khan Kareena	DK	48	**105**	=19	34	**114**	7	43	**105**	=23	36	**110**	=14	**109**	12
Nick Watt	EM	48	**124**	3	24	**99**	=27	34	**102**	=27	26	**108**	=17	**108**	13
Zaynab Ashfaiq	MCO	48	**95**	=39	24	**101**	=24	48	**115**	=5	36	**116**	8	**107**	=14
Chloe Bullock	DK	48	**102**	24	36	**123**	=1	40	**107**	=18	36	**95**	=44	**107**	=14
Johanna Howles	DK	48	**119**	8	36	**103**	=17	48	**94**	=38	36	**110**	=14	**107**	=14
Liz Price	DK	47	**108**	=14	28	**103**	=17	40	**109**	=14	34	**109**	16	**107**	=14
Elise Kelly	MCO	48	**112**	=10	32	**111**	=9	47	**99**	=31	36	**103**	=29	**106**	=18
Susan McGregor	EM	48	**108**	=14	35	**103**	=17	41	**106**	=21	34	**106**	=22	**106**	=18
Connor Gibson	DK	48	**96**	=37	18	**93**	=41	42	**117**	4	35	**113**	=11	**105**	20
Morrison Kirsty	MCO	48	**108**	=14	36	**112**	8	48	**111**	=10	36	**84**	=53	**104**	21
Neil Dawes	DK	47	**110**	12	18	**93**	=41	45	**111**	=10	23	**98**	=38	**103**	=22
Rob Reagan	DK	48	**100**	=28	26	**101**	=24	40	**111**	=10	36	**98**	=38	**103**	=22
Peter Adetunde	MCO	48	**95**	=39	32	**98**	=29	48	**109**	=14	36	**106**	=22	**102**	=24
Teodora Dunec	EM	48	**100**	=28	19	**92**	47	48	**111**	=10	36	**104**	=27	**102**	=24
Kunza Mohammad	MCO	48	**103**	23	26	**98**	=29	42	**108**	=16	36	**100**	=35	**102**	=24

The **Standard Age Score (SAS)** is based on the student's raw score which has been adjusted for age and placed on a scale that makes a comparison with a nationally representative sample of students of the same age across the UK. The average score is 100.

The **Group Rank (GR)** shows how each student has performed in comparison to those in the defined group. The symbol = represents joint ranking with one or more other students.

The **number of questions attempted** can be important: a student may have worked very slowly but accurately and not finished the test and this will impact on his or her results.

For further help with understanding your data please visit: https://www.gl-assessment.co.uk/content-pages/understanding-your-cat4-data/

Figure 6: Student profiles from Group report for teachers

CAT4 Group report for teachers

School: Test School		
Group: Year 7		
Date of test: 13/09/2019	**Level:** D	**No. of students:** 60

Student profiles

The analysis of *CAT4* scores allows all students to be assigned a profile; that is they are assigned to one of seven broad descriptions of their preferences for learning. The Verbal Reasoning and Spatial Ability Batteries form the basis of this analysis and the profiles are expressed as a mild, moderate or extreme bias for verbal or spatial learning or, where no bias is discernable (that is, when scores on both batteries are similar), as an even profile.

The diagram shows the distribution of students across the seven profiles which are indicated by the coloured bands.

- Extreme verbal bias
- Moderate verbal bias
- Mild verbal bias
- No bias
- Mild spatial bias
- Moderate spatial bias
- Extreme spatial bias
- Males
- Females

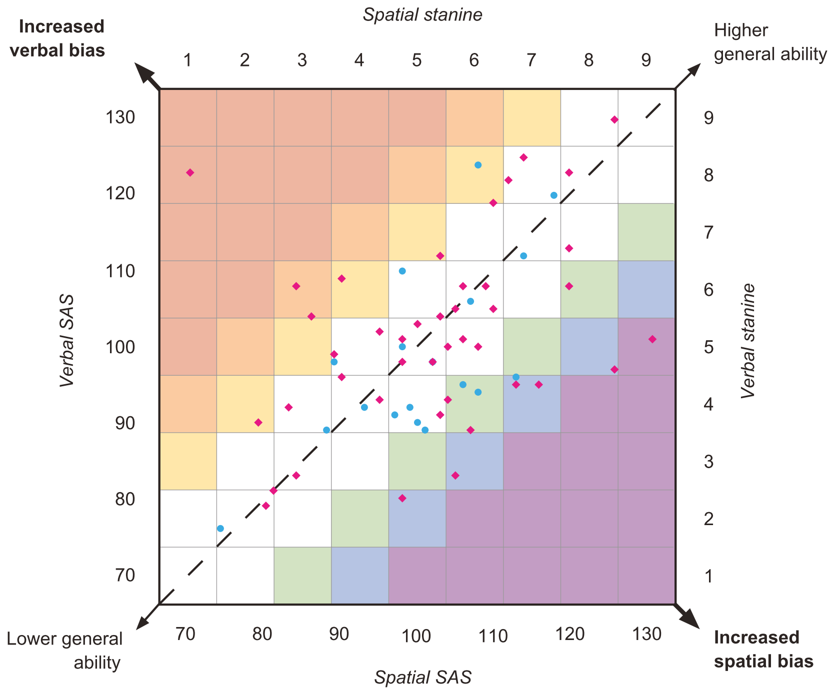


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Figure 7: Student profile characteristics from Group report for teachers

CAT4 Group report for teachers

CAT4

General characteristics of each student profile

It may be helpful to consider which students fall into which broad profile, but this information must be treated with caution as the descriptors are general and not individualised: students' preferences for learning will be influenced by other factors. The *CAT4* Individual report for teachers offers more fine detail.

	National	Group	
	%	%	No. of students
Extreme verbal bias	2%	2%	1
Moderate verbal bias	4%	3%	2
Mild verbal bias	11%	8%	5
No bias or even profile	66%	67%	40
Mild spatial bias	11%	8%	5
Moderate spatial bias	4%	10%	6
Extreme spatial bias	2%	2%	1

Extreme verbal bias

- These students should excel in written work and should enjoy discussion and debate.
- They should prefer to learn through reading, writing and may be very competent independent learners.
- They are likely to be high achievers in subjects that require good verbal skills such as English, modern foreign languages and humanities.
- They may prefer to learn step-by-step, building on prior knowledge, as their spatial skills are relatively weaker, being in the low average or below average range.

Students:
Niamh Ernst

Moderate verbal bias

- Students in this group will have average to high scores for Verbal Reasoning and relatively weaker Spatial Ability with scores in the average range.
- These students are likely to prefer to learn through reading, writing and discussion.
- Step-by-step learning, which builds on prior knowledge incrementally, is likely to suit these students.

Students:

Morrison Kirsty	Shauna Mathews

Mild verbal bias

- Some students with this profile will have low average or below average scores for Verbal Reasoning and relatively weaker Spatial Ability, but the gap between scores will be narrow.
- A slight bias for learning through reading, writing and discussion may be discerned in the students in this group.

Students:

Alex Honkanen	Johanna Howles	Elise Kelly
Alexandra Muraska	Nick Watt	

Figure 8: KS2 indicators from Group report for teachers

CAT4 Group report for teachers

CAT4

School: Test School		
Group: Class 6		
Period of testing: 13/09/2019 – 10/11/2019	**Level:** B	**No. of students:** 30

KS2 indicators

The indicators in this report are for the end of KS2 Standard Assessment Tests (SATs) which are administered for English reading; spelling, punctuation and grammar; and maths. The outcome from these three tests is a scaled score which is based on the student's raw score which in turn is the total number of marks a student scores in a test, based on the number of questions they answered correctly.

New tests are developed each year to the same specification, but because the questions must be different, the difficulty of tests may vary slightly each year. This means that the raw scores must be converted into scaled scores, to ensure accurate comparisons can be made of student performance over time. Every scaled score will represent the same level of attainment for a student each year, so a student who scores 103, for example, in 2016 will have demonstrated the same attainment as a pupil who scores 103 in 2017.

The scale will always be from 80 to 120 and a scaled score of 100 will always represent the expected standard on the test. Students scoring 100 or more will have met the expected standard on the test.

The scaled score should not be confused with the Standard Age Score derived from *CAT4* and other standardised assessments: the scaled score is not adjusted for the age of the student whereas *CAT4* Standard Age Scores factor in the age of each student allowing you to make a direct comparison with other students of the same age across the UK.

Indicators for English are based on the SAS for Verbal Reasoning; the indicator for mathematics is based on the mean SAS. Should scores for one or more of the *CAT4* batteries be missing, indicators will be based on the mean for those batteries administered to the student.

Finally, at the end of KS2 teachers assess students' writing and science: indicators based on teacher assessment are included in this report also.

		End of KS2 indicator (most likely scaled score followed by 'if challenged' scaled score in bold)							
Student name	**Mean SAS**	**Maths**		**Spelling, punctuation and grammar**		**Reading**		**Writing TA**	**Science TA**
Sarah Martin	**123**	111	**114**	112	**115**	112	**115**	GDS	EXS
Josh McLaughlin	**116**	108	**111**	107	**111**	106	**110**	EXS	EXS
Macy Ryan	**113**	107	**110**	106	**110**	106	**110**	EXS	EXS
Nathan Gill	**110**	106	**109**	107	**111**	106	**110**	EXS	EXS
Jennifer Gillespie	**109**	106	**109**	109	**112**	108	**111**	EXS	EXS
Lauren McClenaghan	**109**	106	**109**	104	**108**	103	**107**	EXS	EXS
Eoghan Browne	**107**	105	**108**	108	**112**	107	**110**	EXS	EXS
Sophie Quinn	**107**	105	**108**	104	**108**	102	**106**	EXS	EXS
Katie Ward	**105**	104	**107**	105	**109**	104	**108**	EXS	EXS
Natasha Doherty	**104**	104	**107**	105	**109**	104	**108**	EXS	EXS
Keisha Albright	**103**	104	**107**	102	**106**	101	**105**	EXS	EXS
Ben Doherty	**103**	104	**107**	103	**107**	101	**105**	EXS	EXS
Max Duffy	**102**	103	**106**	101	**105**	100	**104**	EXS	EXS
Aimee Kelly	**102**	103	**106**	101	**105**	100	**104**	EXS	EXS

Teacher assessment codes: WTS – working towards the expected standard; EXS – working at the expected standard; GDS – working at greater depth within the expected standard; HNM – has not met the expected standard.

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Figure 9: Group analysis (by battery) from Summary report for senior leaders

CAT4 Summary report for senior leaders

CAT4

School: Test School		
Group: Year 7		
Date of test: 13/09/2019	**Level:** D	**No. of students:** 60

Group analysis (by battery)

The table below shows mean (average) scores for all students compared with those for the national sample.

	Verbal mean SAS	Quantitative mean SAS	Non-verbal mean SAS	Spatial mean SAS	Overall mean SAS
National average	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
All students	100.6	99.2	98.7	101.6	100.1
90% confidence band	98.0–103.2	96.8–101.5	95.8–101.6	98.8–104.4	97.9–102.2

The table below shows the distribution of scores for all students compared with those for the national sample. The bar chart also presents this information.

Description	Very low	Below average		Average			Above average		Very high
SAS bands	**<74**	**74–81**	**82–88**	**89–96**	**97–103**	**104–111**	**112–118**	**119–126**	**>126**
National average	**4%**	**7%**	**12%**	**17%**	**20%**	**17%**	**12%**	**7%**	**4%**
Verbal	0%	7%	3%	30%	23%	18%	5%	12%	2%
Quantitative	2%	3%	7%	33%	28%	13%	7%	7%	0%
Non-verbal	5%	7%	8%	20%	20%	25%	10%	5%	0%
Spatial	2%	7%	8%	12%	25%	25%	12%	8%	2%

Distribution of scores for all students (by battery) compared with those for the national sample

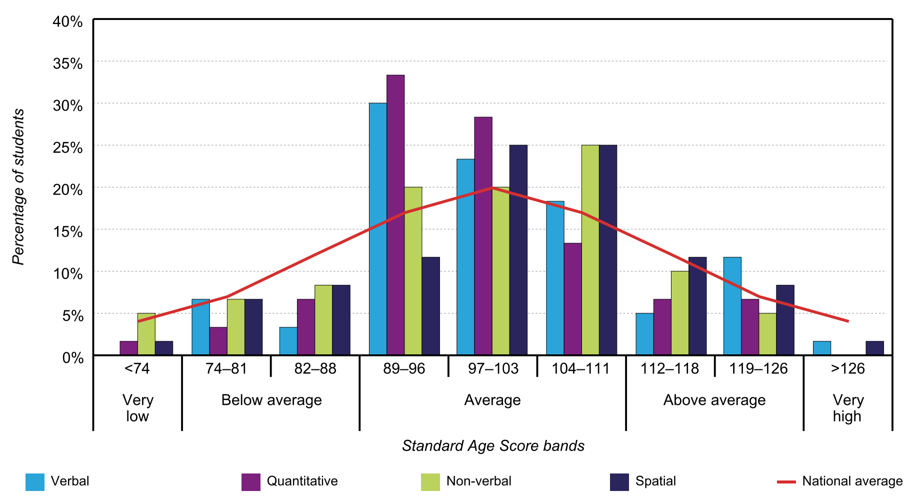


Figure 10: Distribution of scores (by English as an additional language) from Summary report for senior leaders

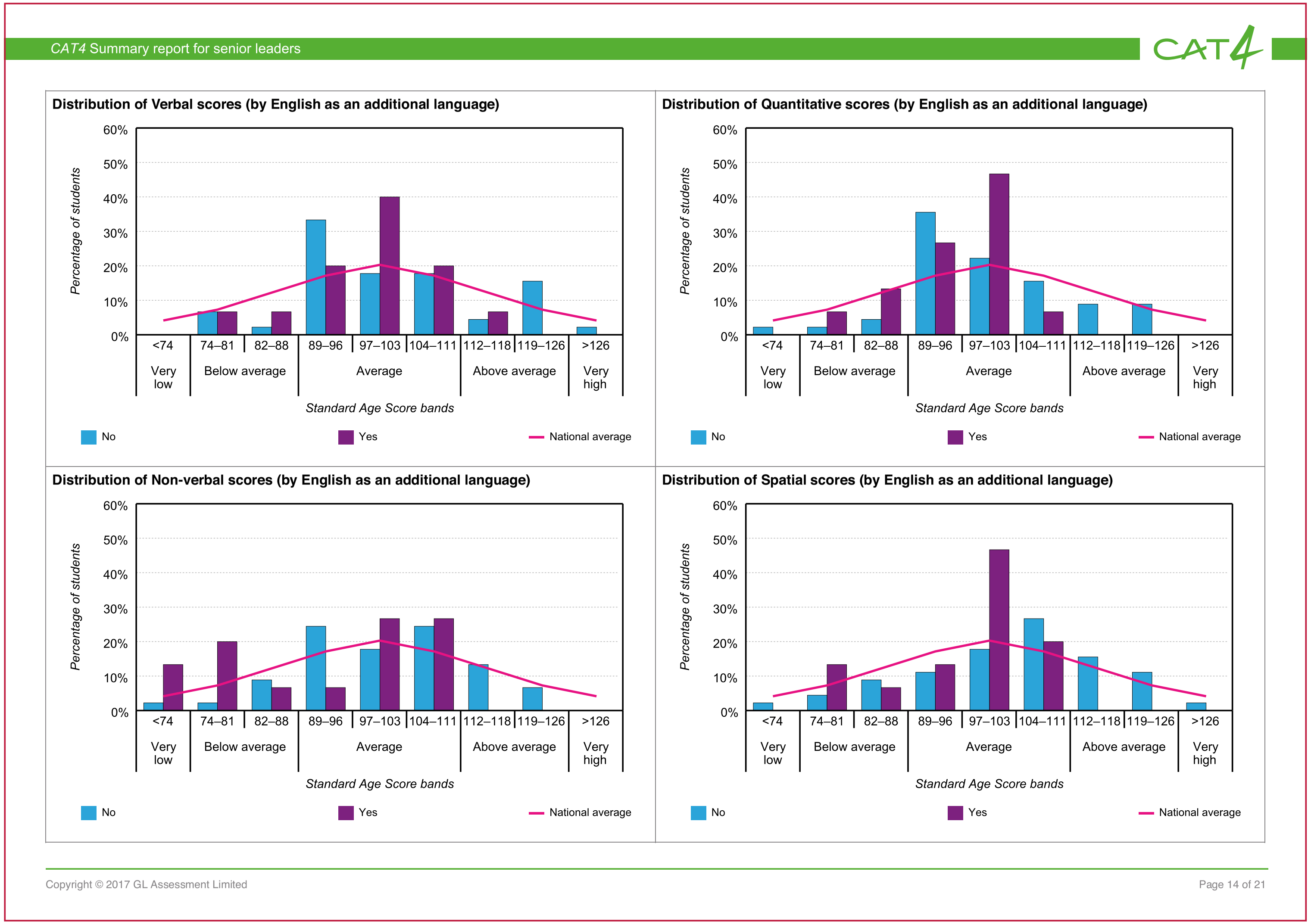


Figure 11: Individual scores from Individual student report for teachers

CAT4 Individual report for teachers

CAT4

Name: Peter Adetunde			
School: Test School			
Group: Year 7			
Date of test: 13/09/2019	**Level:** D	**Age:** 11:01	**Sex:** Male

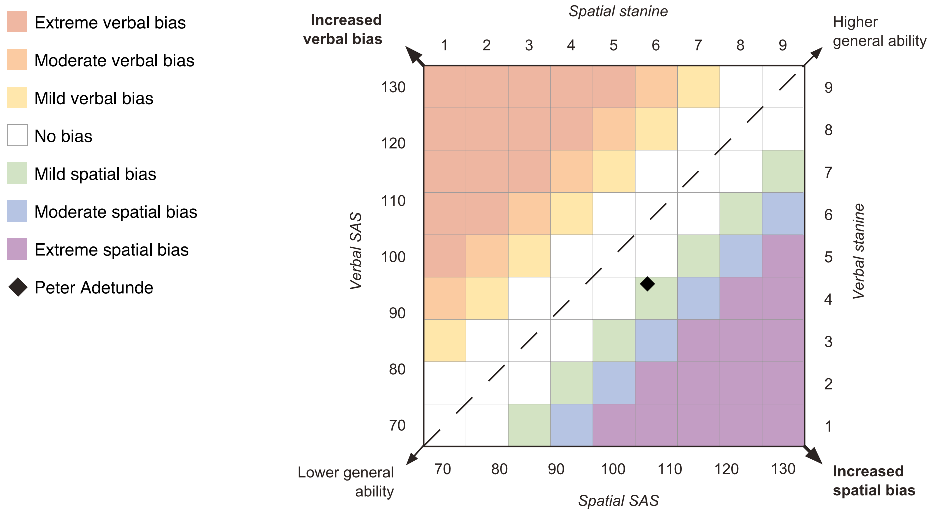
Scores

Battery	No. of questions attempted	SAS	NPR	ST	GR (/60)	SAS (with 90% confidence bands) 60 70 80 90 100 110 120 130 140
Verbal	48/48	**95**	37	4	=39	
Quantitative	32/36	**98**	45	5	=29	
Non-verbal	48/48	**109**	72	6	=14	
Spatial	36/36	**106**	66	6	=22	
Mean	-	**102**	-	-	-	

Profile summary

The analysis of *CAT4* scores allows all students to be assigned a profile; that is they are assigned to one of seven broad descriptions of their preferences for learning. The Verbal Reasoning and Spatial Ability Batteries form the basis of this analysis and the profiles are expressed as a mild, moderate or extreme bias for verbal or spatial learning or, where no bias is discernable (that is, when scores on both batteries are similar), as an even profile.

The black diamond shows Peter's profile, which is indicated by the coloured band.



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For more information about understanding *CAT4* scores, please visit: https://www.gl-assessment.co.uk/content-pages/understanding-your-cat4-data/

Figure 12: KS3 indicators from Individual student report for teachers

CAT4 Individual report for teachers

CAT4

Name: Peter Adetunde			
School: Test School			
Group: Year 7			
Date of test: 13/09/2019	**Level:** D	**Age:** 11:01	**Sex:** Male

KS3 indicators

Results from *CAT4* can give an indication of the level a student will reach at the end of the next Key Stage. A second level is suggested – this is the level a student could reach with additional effort and challenge. This information is helpful when you discuss with your students the targets they should be working towards.

Mean SAS: 102	**Verbal SAS:** 95	**Quantitative SAS:** 98	**Non-verbal SAS:** 109	**Spatial SAS:** 106

	Probability of obtaining each level						Most likely level achieved	'If challenged' level achieved
	3 or less	4	5	6	7	8		
Maths	0%	3%	21%	59%	16%	1%	6b	6a
Art	2%	15%	46%	28%	8%	-	5a	6c
D&T	1%	12%	51%	31%	6%	-	5a	6c
Geography	1%	13%	50%	31%	5%	-	5a	6c
History	2%	15%	52%	27%	5%	-	5a	6c
ICT	1%	12%	58%	24%	4%	-	5a	6c
PE	2%	15%	50%	27%	7%	-	5a	6c
Science	1%	9%	49%	37%	5%	-	5a	6c
English	5%	18%	62%	14%	2%	-	5b	5a
MFL	9%	26%	45%	19%	2%	-	5b	5a
Music	2%	16%	59%	18%	4%	-	5b	5a

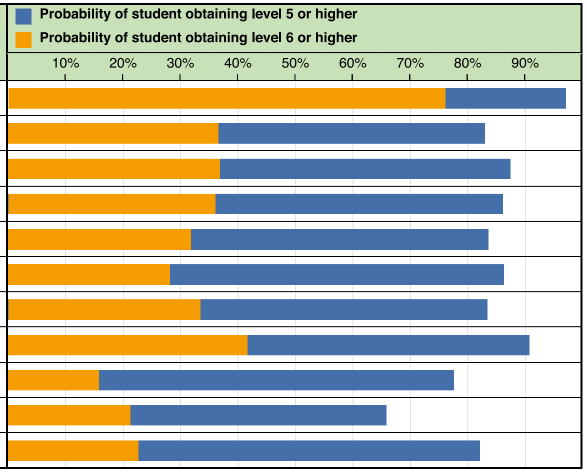

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Figure 13: GCSE indicators for Individual student report for teachers

CAT4 Individual student report for teachers

CAT4

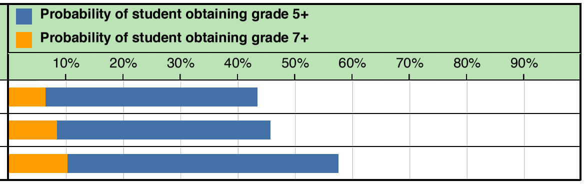
Name: Peter Adetunde			
School: Test School			
Group: Year 7			
Date of test: 13/09/2019	**Level:** D	**Age:** 11:01	**Sex:** Male

GCSE indicators

Results from *CAT4* can give an indication of the level a student will reach at the end of the next Key Stage. A second level is suggested – this is the grade a student could reach with additional effort and challenge. This information is helpful when you discuss with your students the targets they should be working towards.

Mean SAS: 102	**Verbal SAS:** 95	**Quantitative SAS:** 98	**Non-verbal SAS:** 109	**Spatial SAS:** 106

	Probability of obtaining each grade									Most likely grade achieved	'If challenged' grade achieved
	U/1	2	3	4	5	6	7	8	9		
English Language	2%	7%	23%	25%	24%	13%	4%	2%	1%	4.6	5.5
English Literature	5%	8%	18%	24%	23%	14%	5%	2%	1%	4.6	5.5
Maths	1%	3%	9%	30%	33%	14%	7%	2%	1%	5.2	6.1



	Probability of obtaining each grade									Most likely grade achieved		'If challenged' grade achieved	
	U	G	F	E	D	C	B	A	A*				
Art & Design	0%	1%	2%	4%	11%	34%	30%	13%	6%	B/C	5	B	6
D&T – Textiles	0%	1%	1%	5%	14%	23%	32%	18%	6%	B/C	5	B	6
Home Economics	0%	0%	2%	5%	15%	29%	28%	18%	2%	B/C	5	B	6
Media Studies	0%	1%	2%	4%	12%	27%	32%	17%	4%	B/C	5	B	6
Religious Education	1%	2%	3%	7%	13%	24%	28%	18%	6%	B/C	5	B	6
Business Studies	0%	1%	4%	8%	19%	30%	25%	10%	2%	C	4	B	6
D&T – Food	1%	2%	2%	7%	18%	29%	29%	10%	3%	C	4	B	6
D&T – Resistant materials	1%	2%	4%	9%	23%	33%	19%	8%	1%	C	4	B	6
D&T – Systems control	1%	2%	6%	10%	20%	28%	22%	9%	3%	C	4	B	6

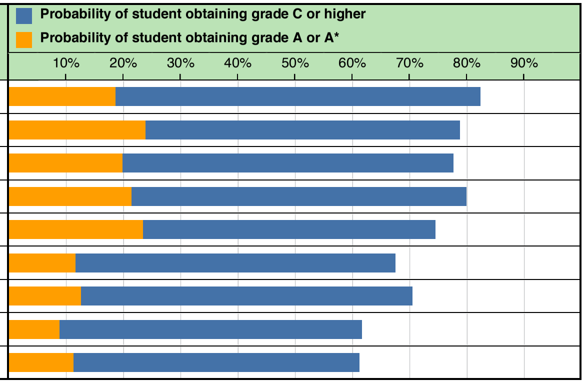


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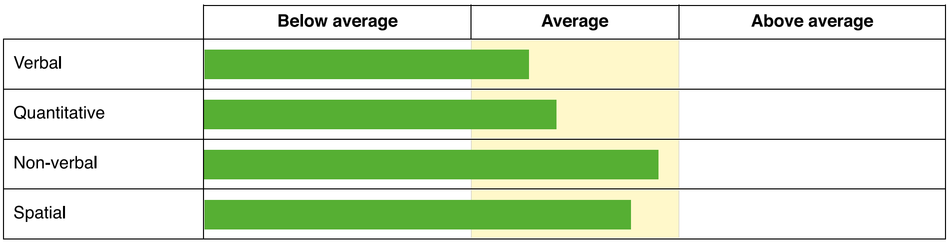
Figure 14: Individual scores from Individual report for students

CAT4 Individual report for students

CAT4

Name: Peter Adetunde			
School: Test School			
Group: Year 7			
Date of test: 13/09/2019	**Level:** D	**Age:** 11:01	**Sex:** Male

Scores



Summary

Your profile of scores from *CAT4* suggests you may have a slight preference for learning by using pictures, diagrams and other visual ways of learning rather than by reading, writing and discussion.

- You may prefer learning that uses visual clues. If so, make sure you use online resources, videos and texts with plenty of pictures that will help you remember key facts and information.
- Use your stronger spatial skills to help across the range of subjects. For example, use mind maps as an aid to remembering key events and characters in a text in English and annotate text to reinforce key facts and information in science. You may find some of your schoolwork challenging, particularly if it involves lots of reading and writing.
- Make sure you understand what you are learning, step-by-step, as it is important that you learn at a pace that is right for you.
- Always ask your teacher to explain anything that is not clear. If you don't understand the meaning of a key word in a lesson, do ask.

Figure 15: GCSE indicators from Individual report for students

CAT4 Individual report for students

CAT4

Name: Peter Adetunde			
School: Test School			
Group: Year 7			
Date of test: 13/09/2019	**Level:** D	**Age:** 11:01	**Sex:** Male

Indicators for GCSE

Subject	Most likely grade achieved	'If challenged' grade achieved	GCSE grade U/1	2	3	4	5	6	7	8	9
English Language	4.6	5.5									
English Literature	4.6	5.5									
Maths	5.2	6.1									

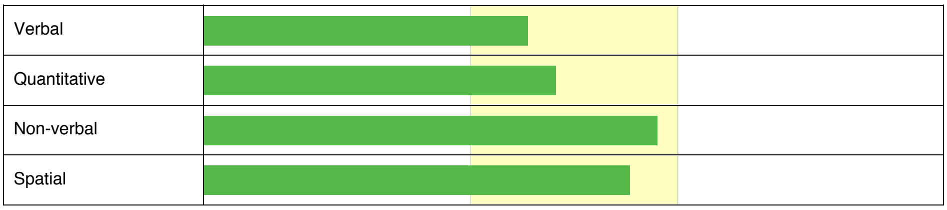
Subject	Most likely grade achieved		'If challenged' grade achieved		GCSE grade U	G	F	E	D	C	B	A	A*
Art & Design	B/C	5	B	6									
D&T – Textiles	B/C	5	B	6									
Home Economics	B/C	5	B	6									
Media Studies	B/C	5	B	6									
Religious Education	B/C	5	B	6									
Business Studies	C	4	B	6									
D&T – Food	C	4	B	6									
D&T – Resistant materials	C	4	B	6									
D&T – Systems control	C	4	B	6									
Drama	C	4	B	6									
French	C	4	B	6									
Geography	C	4	B	6									
German	C	4	B	6									
History	C	4	B	6									
Music	C	4	B	6									
Physical Education	C	4	B	6									
Science – Additional	C	4	B	6									
Science – Biology	C	4	B	6									
Science – Chemistry	C	4	B	6									
Science – Core	C	4	B	6									
Science – Physics	C	4	B	6									
Sociology	C	4	B	6									
Spanish	C	4	B	6									
Statistics	C	4	B	6									
D&T – Electronics	C/D	4	C	4									
D&T – Graphics	C/D	4	C	4									
Information Technology	C/D	4	C	4									

Figure 16: Individual scores from Individual report for parents

CAT4 Individual report for parents

Name: Peter Adetunde			
School: Test School			
Group: Year 7			
Date of test: 13/09/2019	**Level:** D	**Age:** 11:01	**Sex:** Male

Profile



Summary

Peter's profile of scores from *CAT4* suggests he may have a slight preference for a learning that uses visual images – pictures, diagrams, moving images, etc. rather than learning by reading, writing and talking about topics.

- Peter should use online resources, videos and books with plenty of pictures that will help him remember key facts and information.
- Peter may find some of his schoolwork challenging, particularly where a high level of reading and writing is required.
- Peter's stronger spatial skills can be used across the range of subjects and can help support relatively weaker verbal skills in subjects like English and history.
- When you are helping with homework, make sure Peter understands each step of the task before moving on. It is important that Peter learns at a pace that is right for him.
- Tell Peter to ask the teacher to explain anything that is not clear.

Note: In the table above, the yellow shading represents the average range.

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Figure 17: GCSE indicators from Individual report for parents

CAT4 Individual report for parents — CAT4

Name: Peter Adetunde			
School: Test School			
Group: Year 7			
Date of test: 13/09/2019	**Level:** D	**Age:** 11:01	**Sex:** Male

Indicators for GCSE

Subject	Most likely grade achieved	'If challenged' grade achieved
English Language	4.6	5.5
English Literature	4.6	5.5
Maths	5.2	6.1

GCSE point scores: U/1, 2, 3, 4, 5, 6, 7, 8, 9

Subject	Most likely grade achieved		'If challenged' grade achieved	
Art & Design	B/C	5	B	6
D&T – Textiles	B/C	5	B	6
Home Economics	B/C	5	B	6
Media Studies	B/C	5	B	6
Religious Education	B/C	5	B	6
Business Studies	C	4	B	6
D&T – Food	C	4	B	6
D&T – Resistant materials	C	4	B	6
D&T – Systems control	C	4	B	6
Drama	C	4	B	6
French	C	4	B	6
Geography	C	4	B	6
German	C	4	B	6
History	C	4	B	6
Music	C	4	B	6
Physical Education	C	4	B	6
Science – Additional	C	4	B	6
Science – Biology	C	4	B	6
Science – Chemistry	C	4	B	6
Science – Core	C	4	B	6
Science – Physics	C	4	B	6
Sociology	C	4	B	6
Spanish	C	4	B	6
Statistics	C	4	B	6
D&T – Electronics	C/D	4	C	4
D&T – Graphics	C/D	4	C	4
Information Technology	C/D	4	C	4

GCSE grade: U, G, F, E, D, C, B, A, A*

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GL Education®

CASE STUDIES

CAT4®

COGNITIVE ABILITIES TEST

In this section

The short case studies in this section show how *CAT4* is used by schools with both groups and individual students.

Case study 1 covers the use of *CAT4* in a school for transition from primary schooling to secondary schooling with example student profiles of Daniel, with strong spatial and nonverbal reasoning and Maya with an extreme verbal bias.

Case study 2 looks at a school using *CAT4* results for subject setting and subject choice, and covers a strong spatial profile, an extreme spatial bias with very weak verbal skills and a balanced verbal and spatial skills with high quantitative reasoning profile.

Case study 3 covers students with English as an additional language (EAL).

Case Study 1: *CAT4* at Transition

Use of *CAT4*

CAT4 is given to all students who are 11-12 years of age in the first week of school. The Head of Transition explained the importance of getting *CAT4* results back as soon as possible, so that she can use them as part of the identification of students with special educational needs and also 'academically able' students.

CAT4 results are reviewed by the Head of Learning Support and used to identify the following students:

- **The lowest scoring students in each year group:** These students enter a small class of around 10 students where they are given intensive support. This class has a single teacher for around 50% of the time, creating a more nurturing environment. Depending on progress, students may move out of this class into the mainstream classes, although others may remain in the class for the duration of their time at school.
- **Students with stanine scores of 3 or below on the Verbal Reasoning Battery who may have reading difficulties:** These students may have reading difficulties and the scores from the New Group Reading Test (NGRT) that produces further diagnostic information about their reading skills and can be followed up with the YARC and Rapid Assessments. Where a reading test reveals that students do need support in their reading, a plan for this is then put in place.
- **The lowest attaining students at the point of entry to the school, based on their *CAT4* results:** These students are enrolled on a programme of intense literacy support.
- **Any students with an SAS of less than 90 for the Quantitative Reasoning Battery:** These students are made known to the Head of Maths. In evaluating students' needs in the area of Mathematics, *CAT4* results are integrated with the results from other assessments, such as *Progress Tests Maths* (PTM) but they do serve as an early indicator of students who may need additional support.

In addition, *CAT4* results are used to set KS4 (GCSE) targets and stretch target grades for all students[1].

1 In England, the *CAT4* results are used together with the KS2 scaled score alongside NGRT to gain a rounded view of students. (add link to video online)

The *CAT4* data are used as they give the school an overview of the student's strengths and weaknesses. This is then cross-referenced with subject assessments – for example, a high score on the Quantitative Reasoning Battery should indicate that the student will be in a higher Maths set or a high score in Verbal Reasoning suggest they are well places to study a subject load with more content heavy subjects such as history and geography.

Detailed examples of how the school uses *CAT4* results for individual students are given below.

1. Example of strong spatial and nonverbal abilities

Daniel is a student with English as his first language.

Daniel's *CAT4* scores are:

Battery	No. of questions attempted	SAS	NPR	ST	GR (/2)	SAS (with 90% confidence bands) 60 70 80 90 100 110 120 130 140
Verbal	48/48	**97**	42	5	2	
Quantitative	36/36	**105**	63	6	2	
Non-verbal	47/48	**121**	92	8	1	
Spatial	36/36	**129**	97	9	1	
Mean	-	**113**	-	-	-	

Daniel's table of results shows that he completed all questions on each of the *CAT4* batteries, with the exception of the Nonverbal Reasoning Battery where just one of the 48 questions was not answered. Given this, and that all his raw scores are above the chance level, we can be confident that Daniel's profile is likely to be a reliable reflection of his abilities.

Daniel's profile shows his nonverbal ability, and particularly his spatial ability, to be stronger than his verbal and quantitative abilities.

- His verbal SAS is 97, which is equivalent to a stanine of 5. Daniel's percentile rank is 42, showing that he performed as well as or better than 42% of the students' nationality. This level of performance would be described as within the average band.
- Daniel's quantitative SAS is 105, which is equivalent to a stanine of 6. His percentile rank is 63, showing he scored as well as or better than 63% of the national sample. This level of performance would be described as within the average band.
- His nonverbal SAS is 121, which is equivalent to a stanine of 8 and a percentile rank of 92. This level of performance would be described as within the above average band.
- Daniel's spatial SAS is 129, which is equivalent to a stanine of 9 and a percentile rank of 97. This level of performance would be described as within the very high band.
- Daniel's mean SAS of 113 indicates that he is performing at an at least average level in all areas.

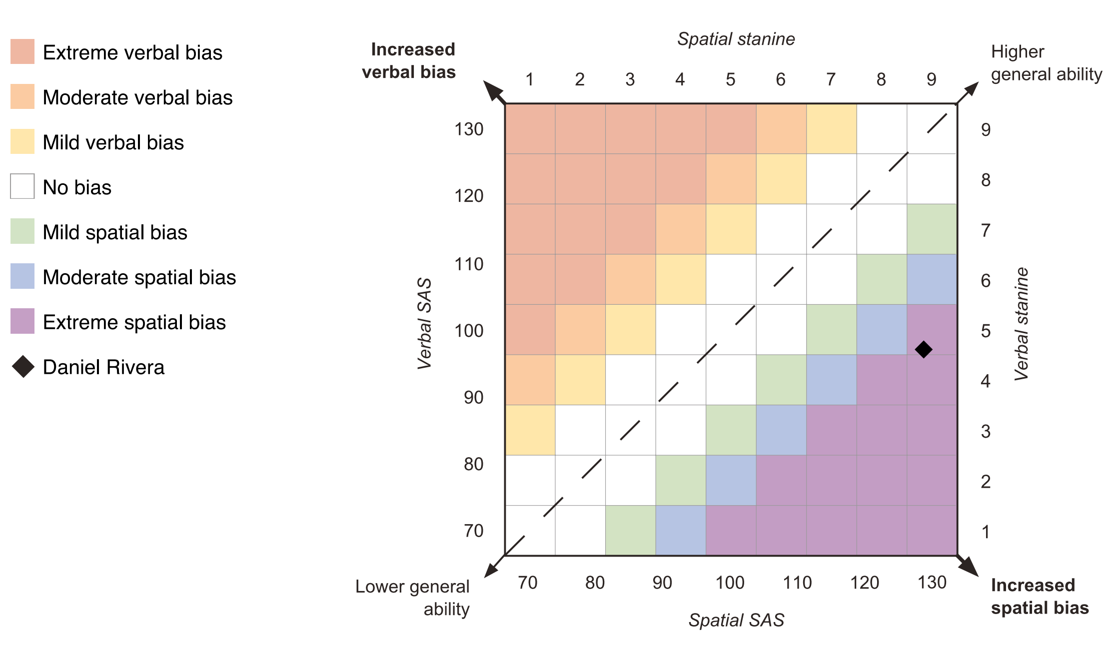
An examination of the **confidence bands** shows the areas of relatively higher and lower performance for Daniel. When looking at differences between scores on the different *CAT4* batteries, it is important to pay attention to the confidence bands. No measurement of abilities is perfect and all contain a degree of error. This error is reflected in the confidence bands, which describe the range within which we can be reasonably certain – in the case of *CAT4*, 90% certain – that Daniel's 'true score' on each battery lies. In this context, true score refers to the score Daniel would achieve if the measurement was completely free of error which no assessment is. Using confidence bands appropriately ensures we do not over-interpret small differences between scores on different batteries, leading us to conclude that differences in performance exist when in fact they do not.

Starting with Daniel's strongest score, which was obtained in the Spatial Ability Battery, we can see that the confidence band for this battery does not overlap with the confidence bands for the Verbal or Quantitative Reasoning Batteries. We can therefore be 90% confident that Daniel's spatial ability is significantly stronger than his verbal or quantitative abilities. Daniel's second highest score was on the Nonverbal Reasoning Battery. The confidence band for the Nonverbal Reasoning Battery does not overlap with the confidence band for the Verbal Reasoning Battery, so we can be at least 90% confident that there is a significant difference between his performance on these two batteries.

Looking at the Nonverbal and Quantitative Reasoning Batteries, we see that there is a very small overlap between the confidence bands. Even though this overlap is very small, it does mean that we cannot be 90% confident that there is a real difference between these two abilities. As the 90% confidence bands for his verbal and quantitative scores overlap, it can be concluded that there is no significant difference in Daniel's reasoning abilities in these two areas.

His ***CAT4* mean** overall SAS of 113 shows Daniel to be performing at at least an average level in all areas. This mean value is found by summing the SAS for each of the four batteries and dividing by four (that is, the number of batteries in *CAT4*). As Daniel's performance varies considerably across the four *CAT4* batteries, his overall score should be interpreted with a degree of caution. Although the overall SAS gives a general indication of his combined reasoning abilities, it does not reveal the considerable variations in Daniel's performance across the four batteries.

Commentary on profile type



The difference between Daniel's verbal and spatial scores of 4 stanine points shows an extreme bias towards spatial processing. This is described in his narrative profile summary as follows:

- This profile demonstrates a distinct relative strength in spatial over verbal learning.
- Daniel should excel when engaged in tasks that require visualisation and will learn well when working with pictures, diagrams, 3D objects, mind maps and other tangible methods.
- Relatively weaker verbal skills may make learning through written texts, writing and discussion less effective.
- Daniel is highly likely to enjoy and learn best through active learning methods such as modelling, demonstrating and simulations and should be encouraged to problem-solve and develop his own ideas through these methods.
- Daniel should do very well in subjects that make the most of his spatial ability, such as Design and Technology, aspects of Science and Geography but will find language-based subjects such as English, History and Modern Foreign Languages less rewarding unless he is equipped with strategies suited to his profile.

Implications for teaching and learning

The Individual student report for teachers also includes narrative on the implications for teaching and learning, as described here:

- Daniel has a very strong understanding of spatial concepts, with average verbal reasoning skills.
- Students with such high levels of spatial ability are often characterised as ‘intuitive’ and as those who see the ‘bigger picture’. This can be at the expense of a lack of attention to detail which may be characteristic of Daniel.
- Daniel should be encouraged to explain his understanding of spatial activities and reflect critically upon them to further enhance his verbal reasoning skills.
- Placing Daniel in paired work with others, perhaps with higher level verbal skills, could provide mutual benefits.
- Daniel may perform better where spatial and visual approaches to learning are used. For example, enacting scenes from a Shakespeare play can provide strong visual images that will help in written composition.

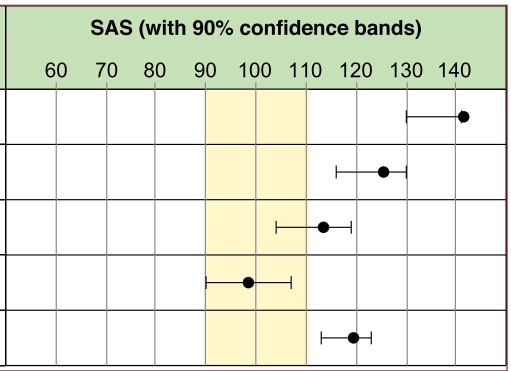
Comment on indicator grades

From the *CAT4* data, Daniel is indicated to achieve 8/9 at GCSE level in subjects such as Design and Technology, Science and Geography. The more literacy based subjects such as English and History indicate 7 at GCSE level. Knowing where his strengths lie would inform his teachers about his strengths and ensure that strategies used are adapted to suit his needs. With these in place Daniel has every opportunity of achieving well in every subject.

2. Example of a highly differentiated profile: an extreme verbal bias

Maya's *CAT4* scores are:

Battery	No. of questions attempted	SAS	NPR	ST	GR (/2)
Verbal	48/48	**141**	100	9	1
Quantitative	36/36	**125**	95	8	1
Non-verbal	47/48	**113**	80	7	2
Spatial	36/36	**98**	45	5	2
Mean	-	**119**	-	-	-



Maya's table of results shows that she completed all questions on each of the *CAT4* batteries, with the exception of the Non-verbal Reasoning Battery where 47 out of the 48 questions were completed. Given this, and that all her raw scores are well above the chance level, we can be confident that Maya's profile is likely to be an accurate indication of his abilities.

At first glance Maya's profile shows a highly differentiated pattern of results, with her strongest score being in the area of verbal ability, followed by quantitative, non-verbal and then spatial.

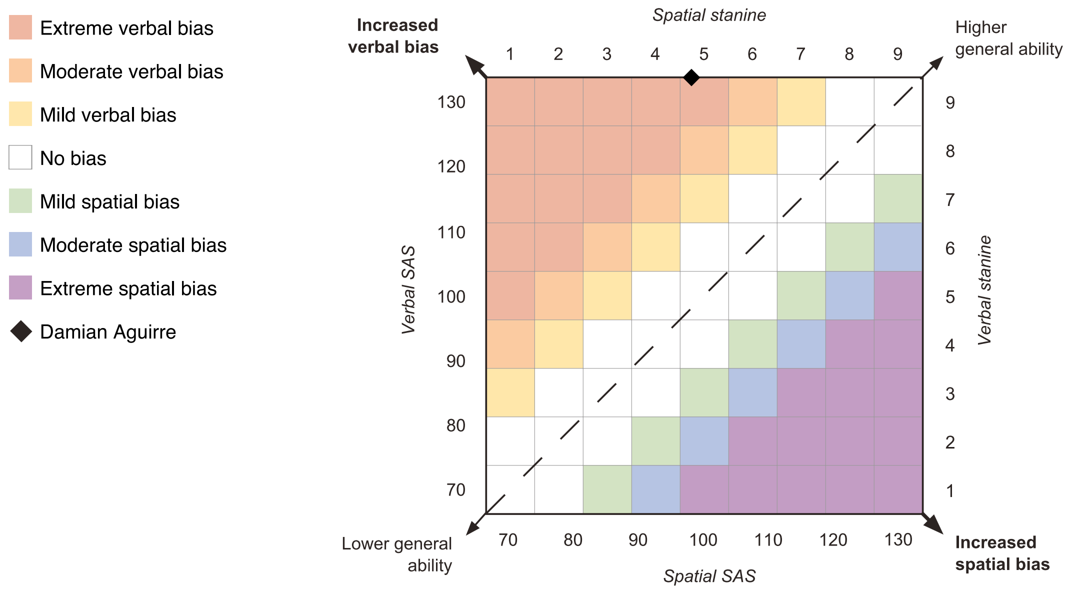
- Maya's strongest score is in the area of verbal reasoning, where she achieved an SAS of 141. This is equivalent to a stanine of 9 and a percentile rank of 100, meaning she is in the top 1% of the population. This level of performance would be described as within the very high band.
- Maya's quantitative SAS is 125, which is equivalent to a stanine of 8. Her percentile rank is 95, showing she scored as well as or better than 95% of the national sample. This level of performance would be described as within the above average band.

- Her nonverbal SAS is 113, which is equivalent to a stanine of 7 and a percentile rank of 80. This level of performance would be described as within the above average band.
- Maya's spatial SAS is 98, which is equivalent to a stanine of 5 and a percentile rank of 45. This level of performance would be described as within the average band.
- Lastly, Maya's mean SAS of 119 indicates that she is performing at an above average level across all areas.

Maya's strongest score is on the Verbal Reasoning Battery. An examination of the 90% confidence bands shows that the confidence band for the Verbal Reasoning Battery overlaps with the confidence band for the Quantitative Reasoning Battery but not with the confidence bands for the Nonverbal Reasoning Battery or Spatial Ability Battery. This indicates that her verbal ability is stronger than her nonverbal and spatial abilities, but that there is no significant difference between her verbal and quantitative scores. The confidence band for Maya's Quantitative Reasoning Battery score overlaps with the confidence band for his Nonverbal Reasoning Battery score but not his Spatial Ability Battery score. This indicates a stronger performance in quantitative than spatial reasoning, but no significant difference between his quantitative and nonverbal abilities. Similarly, as the confidence bands for his Nonverbal Reasoning Battery and Spatial Ability Battery scores overlap, there is no significant difference in his performance in these areas.

Her *CAT4* mean overall SAS of 119 shows Maya to be performing at an above average level across all areas. However, even more so than the profile of Daniel described earlier, her performance varies considerably across the four *CAT4* batteries. Again, this means that while her overall SAS gives a broad indication of his reasoning abilities, it should be used cautiously.

Commentary on profile type



The difference between Maya's spatial and verbal scores of 4 stanine points shows an extreme bias towards verbal processing. This is described in the narrative profile summary as follows:

- This profile demonstrates a distinct strength in verbal compared to spatial learning.
- Maya should excel when engaged in tasks that make the most of his very strong verbal skills, including learning through written texts, writing and discussion.
- Relatively weaker spatial skills – which are, however, in the average range – will make learning through visualisation, working with pictures, diagrams, 3D objects, mind maps and other tangible methods less attractive. With encouragement, these methods can make learning more engaging and effective for Maya.
- Maya is highly likely to enjoy and learn best by talking about learning, ideas and opinions, gathering information through reading and through both factual writing and creative writing tasks.
- Maya should do very well in subjects that make the most of her verbal ability, such as English and History.
- Maya may find certain aspects of subjects such as Science, Design and Technology and Geography less rewarding unless she is equipped with strategies to suit her profile or his spatial skills are developed to more closely match her verbal skills.

Implications for teaching and learning

The Individual student report for teachers also includes narrative on the implications for teaching and learning, as described here:

- Wherever the understanding of spatial concepts is required in the curriculum, such as Art, Design and Technology, Science and Maths, teachers should be aware that Maya may require some additional support.
- However, given her excellent verbal reasoning skills, expectations need to be appropriately high, with enrichment activities to provide challenge and extension.
- While teachers should continue to use a broad and varied range of styles, it is likely that Maya will be a self-motivated and independent learner.
- Teachers should encourage Maya to follow her interests, and she will benefit from a fast pace of instruction, tend to learn very quickly and respond well to tasks that develop her independent study skills.
- Extension activities that require her to form hypotheses, make predictions and test outcomes may be particularly helpful.
- Q&A sessions should be used to develop higher order thinking skills by requiring Maya to justify opinions.
- Maya should be encouraged to read extensively and choose from a wide range of material.
- Maya may enjoy creative writing and discussion and debate and should be encouraged to develop such interest, both in lessons and through extra-curricular activities.

Teacher's perspective

Information gathered from the *CAT4* data is invaluable in identifying those at the top end of the year group and in ensuring that teachers are aware of the students' needs as well as providing opportunities for challenging and extending learning. It offers information for setting up 'groups' with like-minded students that can focus on study techniques, revision and exam preparation. The lowest scoring students in the year group can be identified easily and further assessments administered to establish appropriate interventions. The key message is ensuring teachers are made aware of the identified students and that they are trained in appropriate strategies for the high and low ability students that cater for their specific strengths and weaknesses. When the students are exposed to this within teaching and learning they have every opportunity to make the expected progress, if not more.

Case Study 2: Subject setting and subject choice

Use of *CAT4*

CAT4 is given to all Year 7 and Year 9 students and there is school-wide use of *CAT4* results.

All teachers have access to *CAT4* results within the school's Management Information Service (MIS). The use of *CAT4* at this school is very well established. The Deputy Head Teacher describes *CAT4* as being a 'language' that now permeates the school. *CAT4* results are discussed at meetings and teachers rate *CAT4* as a good indicator of students' potential.

Setting students

The school's experience is that *CAT4* is seen as providing an assessment of students' potential. Therefore, at this school, *CAT4* is used to help stream students into sets. The Quantitative Reasoning Battery is used for allocating students to Maths sets and also for Science, as performance on Maths and Science is seen to be linked closely to this battery. Results from the Verbal Reasoning Battery are used to allocate students to English sets.

The Deputy Head says: "It is important to be flexible when setting students and to be prepared to move them between sets in a way that is appropriate to their abilities." In line with this, eight weeks into the start of term, the performance of all new students is reviewed to determine whether they are in the right set. On average, only 4–5% of students are allocated to a different set on the basis of this review. The Deputy Head adds: "This is seen as providing very clear evidence of the effectiveness of *CAT4* in streaming new students."

Identifying students with literacy needs

CAT4 is used to identify students who may be withdrawn from their classes for more specific intervention. Students scoring in the range of SAS 80 to 90, particularly on the Verbal Reasoning Battery, are put through further language assessment. If this screening identifies particular literacy needs, students are then put through tailored programmes to support their development in these areas.

Target setting and subject choice

CAT4 is relied upon heavily for target setting throughout students' time at school from Years 7 to 11. "As part of this process, students are encouraged to use their *CAT4* scores in their own self-evaluation of appropriate targets", says the Deputy Head. "Individual reports are also used by teachers at option evenings to support discussion about students' subject choices. In addition to tracking whole cohorts, the top 30 performers in each intake are identified on the basis of their *CAT4* scores."

Monitoring intakes over time

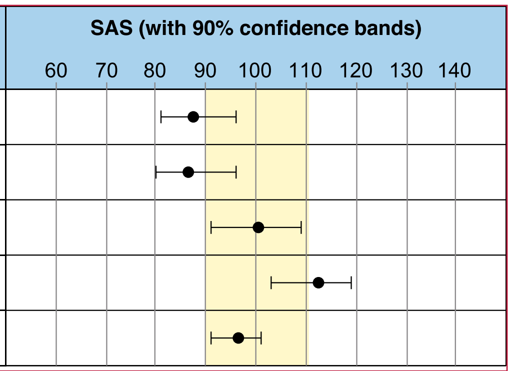
CAT4 results are used to monitor intakes over years and to follow student performance over time. *CAT4* results are summarised to provide average scores on each battery for each year group. This gives a high level understanding of the abilities of each year group entering school and allows the variations in the profiles of different intakes to be tracked.

Examples of how results are used for individual students are given on the following pages.

1. Example of a relatively strong spatial profile

Abigail obtained the following scores on *CAT4*:

Battery	No. of questions attempted	SAS	NPR	ST	GR (/3)	SAS (with 90% confidence bands) 60 70 80 90 100 110 120 130 140
Verbal	48/48	**87**	20	3	2	
Quantitative	36/36	**86**	18	3	3	
Nonverbal	38/48	**100**	50	5	3	
Spatial	35/36	**112**	78	7	1	
Mean	-	**96**	-	-	-	



Abigail's table of results shows that she completed all questions on the *CAT4* Verbal and Quantitative Reasoning Batteries. On the Nonverbal Reasoning Battery she completed 38 out of the 48 questions and on the Spatial Ability Battery 35 out of 36 questions. All her raw scores are well above the chance level, so we can be confident that Abigail's profile is likely to be an accurate indication of her abilities.

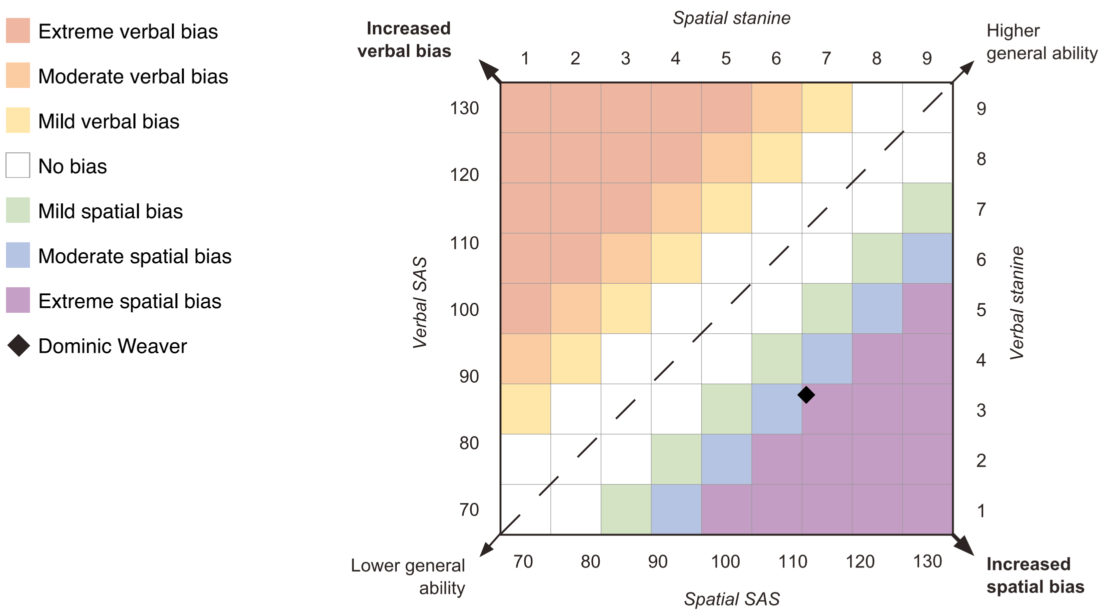
An overview of Abigail's profile shows this to be quite differentiated. She has obtained similar verbal and quantitative scores, that are below average, while her nonverbal score is average and her spatial score is above average.

- Verbal reasoning is one of Abigail's two lowest scores, where she achieved an SAS of 87. This is equivalent to a stanine of 3 and a percentile rank of 20, meaning she performed better than 20% of the national sample. This level of performance would be described as within the below average band.
- Abigail's quantitative SAS is 86, which is equivalent to a stanine of 3. Her percentile rank is 18, showing she scored as well as or better than 18% of the students nationally. This level of performance would also be described as within the below average band.
- Her nonverbal SAS is 100, which is equivalent to a stanine of 5 and a percentile rank of 50. This level of performance would be described as within the average band.
- Abigail's spatial SAS is 112, which is equivalent to a stanine of 7 and a percentile rank of 78. This level of performance would be described as within the above average band.
- Lastly, Abigail's mean SAS of 96 indicates that she is performing at an average level across all areas.

Abigail's strongest score is on the Spatial Ability Battery. An examination of the 90% confidence bands shows that it overlaps with the Nonverbal Reasoning Battery confidence band but not with the confidence bands for the Verbal or Quantitative Reasoning Batteries. This indicates her spatial ability is stronger than her verbal and quantitative abilities, but that there is no significant difference between her spatial and nonverbal scores. The confidence bands for Abigail's scores on the Nonverbal, Quantitative and Verbal Reasoning Batteries all overlap with each other, indicating that there is no significant difference between her performance on these three batteries.

Her *CAT4* profile shows Abigail to be performing in the below average to above average range with an overall SAS of 96. However, as with Daniel's profile described previously, her performance varies considerably across the four *CAT4* batteries. Again, this means that, while her overall SAS gives a broad indication of her reasoning abilities, it should be used cautiously.

Commentary on profile type



The difference between Abigail's spatial and verbal scores of 4 stanine points shows an extreme bias towards spatial processing. This is described in the narrative profile summary for teachers as follows:

- This profile demonstrates a distinct preference for spatial over verbal learning.
- Abigail should perform at a high level when engaged in tasks that require visualisation and will learn quickly when working with pictures, diagrams, 3D objects, mind maps and other tangible methods.
- Weak verbal skills will make learning through written texts, writing and discussion more difficult.
- Abigail is highly likely to enjoy and learn best through active learning methods such as modelling, demonstrating and simulations, and should be encouraged to problem-solve and develop her own ideas through these methods.
- However, she is likely to need support when engaging with written material.
- Abigail should do very well in subjects that make the most of her spatial ability, such as Design and Technology, but will find language-based subjects, such as English, History and Languages difficult unless she is equipped with strategies to suit her profile.

Implications for teaching and learning

The Individual student report for teachers also includes narrative on the implications for teaching and learning, as described here:

- Further investigation of Abigail's weakness in verbal skills would be beneficial.
- A test to establish a reading age (https://www.gl-education.com/products/new-group-reading-test-ngrt/) is recommended to determine whether Abigail is able to access the curriculum.
- Support for language or additional work to build comprehension and vocabulary may be appropriate.
- Abigail is likely to benefit from one-to-one support of a specialist nature.
- Abigail should be encouraged to explain her understanding of spatial activities and reflect critically upon them to develop her verbal reasoning skills.
- Placing Abigail in paired work with others, perhaps those with higher level verbal skills, could provide mutual benefits.
- More rapid progress will be made if strategies used within school can be further supported at home.

Abigail's bias towards spatial thinking is recognised by the school. She is also a student who attains consistently high teacher assessment ratings for 'effort'. Both her effort and level of attainment mean that she will be considered for transfer to a higher set in the near future.

Actions to support teaching and learning

- Ensure Abigail's strengths in the areas of nonverbal and spatial reasoning are understood by her teachers.
- Provide activities that allow Abigail to use her spatial and nonverbal abilities, for example by getting him to consider how she might represent problems visually and presenting information in a way that appeals to her strengths such as a timeline on a washing line in history.
- Encourage Abigail to 'get her ideas down' as they occur to her, and then encourage her to think about structure and presentation using mindmaps or storyboards.
- In areas such as Science and Maths, build on Abigail's strong spatial ability by maximising her opportunities to work with space, shape, designs and visual problem-solving. Then help Abigail to draw connections between these and other aspects of these subject areas.

2. Example of an extreme spatial bias with very weak verbal skills

Rhiannon obtained the following scores on *CAT4*:

Battery	No. of questions attempted	SAS	NPR	ST	GR (/3)	SAS (with 90% confidence bands) 60 70 80 90 100 110 120 130 140
Verbal	48/48	**79**	8	2	3	
Quantitative	36/36	**93**	32	4	2	
Nonverbal	44/48	**101**	52	5	2	
Spatial	36/36	**104**	60	6	2	
Mean	-	**95**	-	-	-	

Her *CAT4* profile shows Rhiannon to be stronger in spatial and nonverbal reasoning than verbal thinking. Her mean SAS score is 95. In a case such as Rhiannon's, the overall score needs to be treated with caution, as her scores on the Nonverbal Reasoning and Spatial Ability Batteries suggest this may underestimate her potential. However, the bias towards spatial learning has been created by very weak verbal skills, so is unlike the case of Daniel in Case study 1 which demonstrates a similar bias but at a much higher level of ability.

A report for the student and for the parent or carer is available and could be used at parents' evening and as a support to Rhiannon in managing her learning. Advice to the student includes:

- *CAT4* shows you have a strong preference for learning by using pictures, diagrams and other visual ways of learning rather than by reading, writing and discussion.
- You may find much of your schoolwork difficult, particularly subjects where you need to read and write a lot.
- You may find difficulty taking part in discussion in class but this will improve the more you take part, so do try.
- Do you find reading difficult? If so, you may need some extra help working one-to-one with a teacher.
- Make sure you understand what you are learning, step-by-step, as it is important for you to learn at a pace that is right for you.
- Always ask your teacher to explain anything that is not clear.
- However, you have good spatial skills and these will help you in very many subjects.
- Do you find Maths difficult but do well in some areas, such as Geometry? Do you like solving problems when these are presented

using diagrams, charts and pictures? If so, this may well explain why you do better in some aspects of learning. You are able to use your spatial skills in certain topics in subjects that may otherwise require step-by-step learning or lots of reading.

- Make sure you use a range of ways to help you learn best, such as texts supported with lots of pictures, videos, photos and examples from the world around you.
- Make notes and revise using mind maps, making notes on texts and creating your own diagrams with pictures or images as reference points.

The report for Rhiannon's parents highlights her potential difficulty with reading and suggestions include:

- Rhiannon's profile of scores from *CAT4* shows she has a strong preference for learning via visual, practical ways, with a weakness in verbal skills that may lead to difficulties in language.
- Rhiannon may find some of her schoolwork difficult.
- Does Rhiannon find reading difficult? If so, she may need some extra help at home under guidance from school.
- When you are helping with homework, make sure that Rhiannon understands each step of the task before moving on. It is important that Rhiannon learns at a pace that is right for her.
- Rhiannon may see the solution to a problem quickly but be unable to talk through the steps needed to reach the answer. Make sure she is helped to explain how she has worked this out.
- Tell Rhiannon to ask the teacher to explain anything that is not clear.
- Encourage Rhiannon to use a range of ways to learn and revise but focus on making mind maps, using pictures, charts and diagrams and using visual clues to help remember key information. This is where her strength lies and should be used as much as possible.

Although Rhiannon may struggle with verbally based material, her performance on the *CAT4* Spatial Ability and Nonverbal Reasoning Batteries shows her to be at least as capable as most students in these areas. Rhiannon's relative difficulties with verbal material should not be taken as an overall indication of her potential.

Actions to support teaching and learning

Rhiannon's *CAT4* profile shows that her nonverbal and spatial reasoning abilities are at or slightly above the mean for her peers. Her verbal and, to a lesser extent quantitative, reasoning abilities reflect the difficulty she has with language. Rhiannon's profile clearly shows that her academic attainment is not likely to be a true reflection of her abilities. It is important that her teachers recognise her potential and provide activities that draw on her nonverbal and spatial strengths to allow her to show her capabilities and so that she remains engaged with education.

3. Example of balanced verbal and spatial skills with high quantitative reasoning

Charlotte obtained the following scores on *CAT4*:

Battery	No. of questions attempted	SAS	NPR	ST	GR (/3)	SAS (with 90% confidence bands) 60 70 80 90 100 110 120 130 140
Verbal	47/48	**91**	28	4	1	
Quantitative	34/36	**115**	84	7	1	
Nonverbal	34/48	**104**	60	6	1	
Spatial	29/36	**85**	16	3	3	
Mean	-	**99**	-	-	-	

Charlotte's table of results shows that she did not manage to complete all of the questions on any of the *CAT4* batteries in the time allowed. This was particularly notable on the Nonverbal Reasoning Battery where she attempted 34 out of 48 questions and on the Spatial Ability Battery where she attempted 29 out of 36. Despite this, her raw scores on each of the batteries are above chance levels. Her results are therefore likely to be a reliable reflection of her abilities.

- Charlotte's second lowest score was on the Verbal Reasoning Battery where she achieved an SAS of 91. This is equivalent to a stanine of 4 and a percentile rank of 28, meaning she performed better than 28% of the national sample. This level of performance would be described as within the average band.
- Charlotte's SAS on the Quantitative Reasoning Battery was 115, which is equivalent to a stanine of 7. Her percentile rank is 84, showing she scored as well as or better than 84% of the national sample. This level of performance would also be described as within the above average band.

- Her SAS on the Nonverbal Reasoning Battery was 104, which is equivalent to a stanine of 6 and a percentile rank of 60. This level of performance would be described as within the average band.
- Charlotte's SAS of 85 on the Spatial Ability Battery is her lowest score, which is equivalent to a stanine of 3 and a percentile rank of 16. This level of performance would be described as within the below average band.
- Lastly, Charlotte's mean SAS of 99 indicates that she is performing at an average level across all areas.

Charlotte's profile therefore suggests that she has a particular strength in quantitative reasoning.

Profile examination

An examination of the confidence bands shows the areas where Charlotte has performed relatively higher and lower. Starting with Charlotte's strongest score, which is on the Quantitative Reasoning Battery, we can see that the confidence band for this battery does not overlap with the Verbal Reasoning or Spatial Ability Batteries. We can therefore be 90% confident that Charlotte's quantitative ability is significantly stronger than her verbal or spatial abilities. Charlotte's second highest score is on the Nonverbal Reasoning Battery. However, as the confidence band for this battery overlaps with the confidence bands for the Verbal Reasoning and Spatial Ability Batteries, we cannot be 90% confident that there is a real difference between these abilities. Similarly, as the 90% confidence bands for her scores on the Verbal Reasoning and Spatial Ability Batteries overlap, it can be concluded that there is no significant difference in Charlotte's reasoning abilities in these two areas.

Her *CAT4* mean overall SAS of 99 shows Charlotte to be performing at an average level across the *CAT4* batteries. While overall SAS scores can provide a useful indicator of general reasoning abilities, they can also mask the profile of scores that underlie this summary. In Charlotte's case, we see that her profile of scores spans one standard deviation above the mean (quantitative SAS of 115) to almost one standard deviation below it (spatial SAS of 85).

Charlotte's profile appears to be fairly balanced in terms of her verbal and spatial abilities, but her higher scores on the Quantitative and Nonverbal Reasoning Batteries suggest that further investigation is needed. It is very unusual for a student to have much stronger quantitative and nonverbal scores than both their verbal and spatial scores (this would only occur approximately six times in 1,000 students). Underpinning performance in these two areas should be similar level skills in either verbal or spatial ability or both. This suggests that one or other of the verbal or spatial scores might not accurately reflect Charlotte's true ability. Charlotte's score of 91 for verbal reasoning is just outside the cut-off for further assessment for reading difficulties. In this case it would be most appropriate to assess Charlotte further as she may have a reading difficulty such as **dyslexia** or difficulties with comprehension. It could therefore be that she really has a relative bias to verbal thinking, but this is not shown because her verbal abilities have not been able to develop to their potential or because she has dyslexic-type difficulties that limit her ability to deal with the printed word.

Actions to support teaching and learning

On the basis of her *CAT4* profile, Charlotte has been attending a language support group for one session a week. An initial diagnostic assessment indicated that Charlotte was likely to have difficulties with her verbal comprehension. A specific programme of support has now been put in place to support Charlotte.

Case Study 3: Students With English as an Additional Language (EAL)

Research over three decades has shown that students who are taught in a language that is not their home language may take up to seven or even 10 years to achieve parity in educational outcomes with their first language peer group. Building on work done in Canada (Cummins, 1981[1]), large-scale studies in the US (Collier and Thomas, 1989,[2] 1997[3]) found that students of this type aged between eight and 11 were the fastest achievers and that, for students in this age range, two years of education in their first language was a significant variable with a positive impact on academic achievement in their additional language. Collier and Thomas also found that, after two years, attainment in functional English was comparable to their mainstream peer group. In Mathematics, attainment was actually well above average, demonstrating that, for aspects of language which are taught directly (such as Grammar and Punctuation) and where knowledge and skills can be transferred, English language learners do as well as or better than their peers.

...[It] takes between five and seven years for a child to be working on a level with first language speakers as far as academic language is concerned.

The same study found that students starting to learn in English between the ages of 12 and 16 had the lowest scores on standardised tests at the equivalent of Y11/S5: these students run out of time to acquire the level of English proficiency to perform at the same level as their mainstream peer group.

Cummins coined the term *CALP* (Cognitive Academic Language Proficiency) and, as the name suggests, this is the basis for a child's ability to cope with the academic demands placed upon him or her in the various subjects across the curriculum. Cummins states that, while many children develop native speaker fluency (which he calls Basic Interpersonal Communication Skills, or *BICS*) within two years of immersion in the target language, it takes between five and seven years for a child to be working on a level with first language speakers as far as academic language is concerned.

These studies focused on a particular group of students entering the

[1] Cummins, J. (1981) *Bilingualism and Minority-language Children*. Toronto: Oise Press.

[2] Collier, V. and Thomas, W. (1989) 'How quickly can immigrants become proficient in school English?' *Journal of Educational Issues of Language Minority Students*, 5, 26–38.

[3] Thomas, W.P. and Collier, V.P. (1997) 'School effectiveness for language minority students.' *National Clearinghouse for English Language Acquisition (NCELA) Resource Collection Series*, No. 9, December 1997.

US or Canada, which is only partly representative of students in UK schools who have English as a second language.

Schools work to support students like those in the research findings described above.

Three out of the four batteries in CAT4 have very little language content and so students can be supported where necessary by translating administration instructions.

Issues for consideration

- The length of time the student has been educated in English:
  - If this is less than five years, adaptation, such as the translation of administration instructions, may be considered to ensure that *CAT4* is accessible.
  - If this is two years or less, it may be inappropriate to give the Verbal Reasoning Battery but the administration of the other batteries can be adapted to ensure accessibility.
- The point at which the student entered school to learn in English may be significant:
  - Children who have entered an English medium or bilingual school when older may well be more disadvantaged than those in the eight to 11 age range, for example.
- The student's attainment in subjects across the curriculum and level of English language acquisition demonstrated:
  - *BICS* may be highly competent.
  - Aspects of *CALP* may also be average or above (for example, in functional English and Mathematics).
  - Higher order skills in Reading and Reading Comprehension in the acquired language should be part of the decision on how the tests are provided too.

Some implications of testing

- Indicators are likely to be an **underestimate** of eventual attainment if based on all the batteries of *CAT4* and where a student's level of English language acquisition disadvantages them in the Verbal Reasoning Battery (and assuming that a student in, say, Year 7 continues to learn English and so improve their *CALP*). In such cases it may be better to retest when English language acquisition is more advanced, at Y9 or above.
- Indicators for English and Languages are usually based on the Verbal Reasoning Battery, so these may contain a greater degree of variability when based on the mean score from the other three batteries.

- Indicators will be based on the mean of the scores from the Nonverbal Reasoning, Quantitative Reasoning and Spatial Ability Batteries, where the Verbal Reasoning Battery is omitted.
- The Nonverbal Reasoning Battery involves reasoning with both language – the student will think through the tasks in his or her language – and spatial reasoning (with shapes or patterns), so the score from this part of *CAT4* will be especially useful when supporting students for whom English is an additional language as it requires the mustering of two types of reasoning.
- The Quantitative Reasoning Battery also uses a mixture of verbal and spatial reasoning, although the verbal element is more limited than in the Nonverbal Reasoning Battery. For example, it may only involve recalling things like 'three times two is six', whereas the Nonverbal Reasoning Battery can necessitate finding words to describe a wide range of shapes and operations.

Adaptations to the administration

- Administration in the student's first language must be carried out separately from the group administration and, if more than one additional language is to be accommodated, separate test sessions or rooms must be arranged.
- Translation and administration of instructions and examples should be carried out by a teacher, teaching assistant, learning mentor or similar practitioner whose first language is the same as that of the student. A friend or family member is not an appropriate person to translate and administer *CAT4*. The test items must not be translated.
- Translated administration instructions should be prepared in advance and must follow those in the published test as closely as possible. Translated material should be written down before being read out so that all students tested in any language are given the same instructions.
- All timings must be adhered to and no assistance should be given in accessing the actual test questions. So, for example, the questions in the Verbal Reasoning Battery must not be translated nor should any other elaborations be made to any of the other batteries, such as explaining the transformation rules that underpin the quantitative questions.

Example

An example of how students with English as an additional language are successfully included in *CAT4* testing is seen in a primary school in Berkshire. This is aschool where about three-quarters of the students have English as an additional language.

When children come into school, those with English as an additional language receive intensive language support, which has a big impact on their achievement. The Head Teacher says: "Our programme to support these children has been very successful and we find that by the end of the first year many are outstripping their peer group.

CAT4 is administered in January each year to Years 4 and 5 and is used to:

- assess the ability of the whole year group, which does vary year-on-year
- contribute to provision mapping for SEN children
- set targets for individual students.

The Head Teacher comments: "It is important to the school to know about the ability of a whole year group, and for this reason we tend to include all our students in *CAT4*. As long as we are aware of any factors that might affect a student's scores it would be our preference to test all the students. Our cohort is fairly stable, although we do have a number of students joining higher up the school who need English language support."

The Head continues: "*CAT4* adds information that complements teachers' own assessments. *CAT4* data is a useful additional source of information about a whole year group. *CAT4* offers objective evidence of the ability levels across the group."

Two groups of children were tested as part of the *CAT4* standardisation. Proper interpretation of *CAT4* profiles necessitates setting the scores in context by considering background information about the children. For example, three Year 6 children tested with *CAT4* Level C obtained a similar profile, indicating an extreme spatial bias. However, once some background information was factored in and the *CAT4* scores given a context, it is possible to see the different reasons for this bias that has been revealed through testing with *CAT4*. Two of the children have special needs which mean their spatial abilities are genuinely higher than their verbal abilities. The remaining child has a verbal score that is probably being suppressed by the fact that he is still learning English. He may in fact have a balanced profile.

The children's scores are as follows:

Both Arif and Omar have English as an additional language. However, Arif has been in school from the age of 4/5, whereas Omar, whose first language is Arabic, joined at the beginning of Year 6 when he was 10. An important consideration for Arif is that he has a diagnosed speech delay which may well make the tests in the *CAT4* Verbal Reasoning Battery especially difficult for him. His strengths in the Quantitative Reasoning and Spatial Ability Batteries will help him do well in Maths and Science and can be drawn on to support and develop his verbal skills. The report for Arif recognises that support for literacy will be required (and he is receiving this).

	Verbal			Quantitative			Non-verbal			Spatial			Overall	
Student name	**No. attempted (/48)**	**SAS**	**GR (/3)**	**No. attempted (/36)**	**SAS**	**GR (/3)**	**No. attempted (/48)**	**SAS**	**GR (/3)**	**No. attempted (/36)**	**SAS**	**GR (/3)**	**Mean SAS**	**GR (/3)**
Omar Mohamed	48	**88**	1	36	**106**	2	48	**106**	3	36	**113**	2	**103**	2
Arif Phull	48	**85**	2	36	**116**	1	48	**107**	2	36	**115**	1	**106**	1
Ellie Smith	48	**83**	3	36	**91**	3	48	**111**	1	36	**111**	3	**99**	3

The Individual report for teachers for these three students says:

- Arif (and/or Omar and Ellie) should be encouraged to explain his or her understanding of spatial activities and reflect critically on them to develop his or her verbal reasoning skills.

Omar's spatial skills are also above average. His score on the Nonverbal Reasoning Battery is of interest as it may be lower than his score on the Spatial Ability Battery because Omar's verbal reasoning is below average. However, it is highly unlikely that his score on the Verbal Reasoning Battery is an accurate reflection of his verbal skills. So, retesting in Year 8 or Year 9 at age 12-13, 13-14 might offer a much more accurate profile of his skills which may then be more evenly balanced and in the above average range rather than as his current Year 6 test results suggest. However, including Omar alongside his peer group in the test session is more than appropriate, as *CAT4* has allowed him to demonstrate his skills in all areas, especially his particularly strong spatial ability.

Ellie, whose first language is English, has dyslexia, although her teacher reports that she is doing extremely well in Reading and making good progress. Ellie is clearly able to bring together her verbal and spatial reasoning skills in the Nonverbal Reasoning Battery (SAS 111), but it is likely that her strengths are more spatial than verbal and that she will go on to do well in a range of subjects at secondary school – Science, Design and Technology and Physical Education, for example – as long as her language is supported and continues to improve.

"We will continue to include all our students when we test with *CAT4*" says the Head Teacher. "We have just decided to use the Pupil Attitudes to Self and School (*PASS*), (https://www.gl-education.com/products/pupil-attitudes-to-self-and-school-pass/) which can be used alongside *CAT4* and teacher assessment to give an even fuller picture of our students' potential and how to make sure they do the best they can."

Pupil Attitudes to Self and School (PASS) provides vital insight into students' attitudes and mindsets that may be having a negative impact on their attainment.

Developed by a team of chartered educational psychologists and four universities over a number of years, the PASS digital survey takes just 20 minutes to complete and provides teachers with a highly reliable and valid measurement of their students' attitudes.

PASS looks at nine attitudinal factors that are proven to be significantly linked to educational goals.

The easy-to-interpret report generated once the survey has been completed allows schools to detect possible barriers to student learning, including issues around confidence, resilience, motivation and concentration. The survey results enable you to identify, track and monitor the type of teaching and intervention each student requires, helping to raise attainment and ensure student wellbeing.

PASS also adds valuable insight to the ability data you have from *CAT4* by explaining why some students' attainment doesn't appear to match their ability.

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APPENDICES

CAT4®

COGNITIVE ABILITIES TEST

In this section

APPENDIX A: Sample letters and guidance for communicating with parents or carers

Guidance and sample letters are given here to support your communications with parents or carers both before and after testing with *CAT4*.

Pre-testing

Many schools and other establishments choose to communicate with parents or carers before testing takes place, to inform them of their plans and give an overview of what the students will be doing.

It is likely that any communication with parents or carers prior to testing will be kept intentionally brief, as shown in the pre-testing sample letter provided on the next page. However, the following list provides some guidelines to assist with your communications, whether orally or in writing.

- Stress the school's commitment to identifying and addressing the needs of each individual student in order to understand and maximise their potential.
- Explain that the test the students will take is delivered either in paper or digital format and that there are four parts to *CAT4*, each measuring the students' reasoning skills in a different area.
- Explain that testing with *CAT4* is part of the school's regular assessment regime and that all the students in the year group(s) will be tested.
- Emphasise that no preparation can be done for the *CAT4* test and so it is important that the students do not become anxious as they all have an equal chance to demonstrate their reasoning ability.
- Parents or carers should understand that information from *CAT4* forms part of the process of supporting their children and helping them achieve their potential. Other information, including teachers' own assessments, is very important. Results from *CAT4* will be used in combination with a range of data to set targets for learning and identify any particular need, for example a need for support in literacy.

Emphasise that no preparation can be done for the *CAT4* test

- Parents or carers should be made aware that they will be updated after the assessment so they know how their child has done and the school's plans, if any, for further follow-up.

Pre-testing sample letter

Dear Parent/Carer,

At [insert establishment name] we believe in providing each and every student with the opportunity to realise their full potential and achieve at the highest level. To gain a better understanding of the learning needs of our students, we are going to be administering a series of short cognitive ability assessments with all students in year/grade [x]. We will then use the results from the assessment to improve the support we provide your child in their learning, and to determine whether further intervention is needed.

The Cognitive Abilities Test (CAT4) assesses a student's ability to think across four different reasoning batteries:

Verbal reasoning – thinking with words

Quantitative reasoning – thinking with numbers

Nonverbal reasoning – thinking with shapes

Spatial reasoning – thinking with shapes and space

I would like to stress that this is an assessment of ability and not attainment, so no pre-learning or preparation is necessary. Your child should not feel worried about taking CAT4 as prior knowledge is not required to complete it. The results will be used together with our internal assessment practices, to inform teachers about the strengths and development areas of each student.

Once the assessment has been carried out I will be in touch again to discuss the results and next steps.

If you have any queries or concerns, please contact us.

Yours faithfully,

Post-testing

An optional report on the individual student is available to support feedback to parents or carers.

This Individual report for parents strips away much of the technical detail that is included in the Group report for teachers and the Summary report for senior leaders, simply presenting the student's results as below average, average or above average for each part of *CAT4*. A series of statements, tailored for parents, is included to explain what the results mean (in terms of the profile of learning bias demonstrated by the student on the test) and how learning may be affected. Recommendations focus on how the parent or carer can work with the school to support the student at home.

In addition to the Individual report for parents, you may wish to provide a supporting letter explaining the process and outcomes. The following list provides you with guidelines to assist with this communication, whether orally or in writing.

Our post-testing guidelines and post-testing sample letter provided below overlap significantly with those already provided for pre-testing. This is because many schools and establishments may choose not to contact parents or carers at all prior to testing taking place, meaning a full explanation is required post-testing. In the case of communication with parents or carers both before and after testing, you may choose to edit the post-testing sample letter to avoid such repetition.

- Stress the school's commitment to identifying and addressing the needs of each individual student in order to understand and maximise their potential.
- Explain that there are four component parts to *CAT4*, each measuring the child's reasoning skills in a different area.
- Explain that testing with *CAT4* is part of the school's regular assessment regime and that all students in the year group(s) have been tested.
- You may wish to summarise in the letter the specific outcomes and recommendations from the test for that individual student (which are also shown on the Individual report for parents).
- Parents or carers should be reassured that if they have any questions or concerns or would like any further advice on how best to support their child, they should contact the school.

Post-testing sample letter

Dear Parent/Carer,

At [insert establishment name] we believe in providing each and every student with the opportunity to realise their full potential and achieve at the highest level. To gain a better understanding of the learning needs of our students, we have carried out a series of short cognitive ability assessments with all students in year/grade [x]. The results from the assessment will help teachers understand the learning needs of your child so that targeted support can be provided, appropriate to his/her strengths and development areas.

The Cognitive Abilities Test (CAT4) assesses a student's ability to think across four different reasoning batteries:

Verbal reasoning – thinking with words

Quantitative reasoning – thinking with numbers

Nonverbal reasoning – thinking with shapes

Spatial reasoning – thinking with shapes and space

I would like to stress that this is an assessment of ability and not attainment, so no pre-learning or preparation was required. CAT4 has been conducted as part of our regular assessment processes and the results will be used together with our internal assessment practices, to support your child in their learning and ensure he/she can reach his/her true potential.

A copy of the Individual Report for Parents has been included here, which represents the scores on a bar chart and summarises the results in a brief commentary. The yellow section in the middle of the bar chart highlights where the average scores lie. The commentary underneath details how your child learns best and offers suggested strategies for how you can support his/her learning at home. I hope you will find this useful and will continue to work with us in ensuring your child makes excellent progress throughout their time in school with us.

If you have any questions about the report or would like to discuss the assessment further, please contact us.

Yours faithfully,

[1] If possible, it is helpful to parents to discuss the report with them on a suitable occasion before sending it out.

APPENDIX B: Articles of interest to *CAT4* users

The first two articles in this Appendix (Appendix B) illustrate the relevance of spatial testing, thereby highlighting the importance of recognition and testing of spatial intelligence in assessing students' development in *CAT4*. The third looks at analysing *CAT4* data in an English as an additional language (EAL) context.

Recognizing Spatial Intelligence

Our schools, and our society, must do more to recognize spatial reasoning, a key kind of intelligence

By Gregory Park, David Lubinski and Camilla P. Benbow, *Scientific American*,™ November 2, 2010 online

Ninety years ago, Stanford psychologist Lewis Terman began an ambitious search for the brightest kids in California, administering IQ tests to several thousand of children across the state. Those scoring above an IQ of 135 (approximately the top 1 percent of scores) were tracked for further study. There were two young boys, Luis Alvarez and William Shockley, who were among the many who took Terman's tests but missed the cutoff score. Despite their exclusion from a study of young "geniuses", both went on to study physics, earn PhDs, and win the Nobel prize.

How could these two minds, both with great potential for scientific innovation, slip under the radar of IQ tests? One explanation is that many items on Terman's Stanford-Binet IQ test, as with many modern assessments, fail to tap into a cognitive ability known as spatial ability. Recent research on cognitive abilities is reinforcing what some psychologists suggested decades ago: spatial ability, also known as spatial visualization, plays a critical role in engineering and scientific disciplines. Yet more verbally loaded IQ tests, as well as many popular standardized tests used today, do not adequately measure this trait, especially in those who are most gifted with it.

Spatial ability, defined by a capacity for mentally generating, rotating, and transforming visual images, is one of the three specific cognitive abilities most important for developing expertise in learning and work settings. Two of these, quantitative and verbal ability, are quite familiar due to their high visibility in standardized tests like the Scholastic Aptitude Test (SAT). A spatial ability assessment may include items involving mentally rotating an abstract image or reasoning about how an illustrated mechanical device functions. All three abilities are positively correlated, such that someone with above average quantitative ability also tends to have above average verbal and spatial ability. However, the relative balance of specific abilities can vary greatly between individuals. While those with verbal and quantitative strengths have opportunities to be identified by standardized tests or school performance, someone with particularly strong spatial abilities can go unrecognized through these traditional means.

A recent review, published in the *Journal of Educational Psychology*, analyzed data from two large longitudinal studies. Duke University's Jonathan Wai worked with two of us (Lubinski and Benbow) and showed how neglecting spatial abilities could have widespread consequences. In both studies, participants' spatial abilities, along with many others, were measured in adolescence. The participants with relatively strong spatial abilities tended to gravitate towards, and excel in, scientific and technical fields such as the physical sciences, engineering, mathematics, and computer science. Surprisingly, this was after accounting for quantitative and verbal abilities, which have long been known to be predictive of educational and occupational outcomes. In a time when educators and policy-makers are under pressure to increase the number of students entering these fields, incorporating knowledge of spatial ability into current practices in education and talent searches may be the key to improving such efforts.

The first source of data reviewed by Wai was a massive longitudinal study, Project Talent. While several studies have investigated the role of spatial abilities in tasks involving visual searching or path finding, Wai and colleagues focused on the relationship between spatial abilities and interests, finding that adolescents with strong spatial abilities also show greater interest than most in working with their hands, manipulating and tinkering with tangible things. While building, repairing, and working with inanimate objects might bore some, spatially gifted adolescents reported a preference for such activities. When those same individuals were contacted again in their late 20s, they had pursued and persisted in scientific and technical fields, earning bachelor's, Master's and doctoral degrees in these areas at higher rates than their peers. These findings suggest that the same child who likes to dismantle and reassemble old electronics may be particularly well-suited for doing the same in adulthood with electrons, molecules, or microchips.

While those with verbal and quantitative strengths enjoy more traditional reading, writing, and mathematics classes, there are currently few opportunities in the traditional high school to discover spatial strengths and interests. Instead, students who might benefit from hands-on, technical material must find an outlet on their own time, or just wait until their post-secondary education. And, in the worst case, they may drop out of the educational system altogether.

The second source of data reviewed by Wai came from a large-scale talent search. Talent searches, similar to Terman's project, use psychometric assessments to identify youths with exceptional talents, usually in quantitative or verbal ability, that might not be recognized in a traditional classroom setting. One of the goals of modern talent searches is to provide the additional educational opportunities and experiences needed by these students for optimal development. Adolescents with exceptionally high quantitative ability, for example, can benefit greatly by additional instruction or an accelerated mathematics curriculum that provides them with developmentally appropriate material, such as advanced calculus rather than algebra. When youths identified by talent searches are appropriately accelerated according to their intellectual strengths, they report higher satisfaction with their education as adults.

The talent search data reviewed by Wai was collected from the Study of Mathematically Precocious Youth (SMPY), a talent search initiated at Johns Hopkins University in the early 1970s. SMPY identified intellectually precocious adolescents at or before age 13 based on scores on the quantitative and verbal subtests of the SAT. After identification, many of these same adolescents were administered measures of spatial ability. Although these participants were selected based on their exceptional quantitative and verbal ability, there was wide variability in the spatial abilities within the sample.

These participants have now been followed for over 25 years, and the variability in spatial abilities was found to be predictive of educational and occupational outcomes, even after accounting for verbal and quantitative abilities. Similar to the subjects from Project Talent, the SMPY participants who earned bachelors, Master's, and doctoral degrees in science and engineering fields had especially strong spatial abilities compared to the rest of the sample. The same trend was found among those who had occupations in these fields at age 33.

Due to the neglect of spatial ability in school curricula, traditional standardized assessments, and in national talent searches, those with relative spatial strengths across the entire range of ability constitute an under-served population with potential to bolster the current scientific and technical workforce. Alvarez and Shockley found their way despite being missed by the Terman search, and each had considerable impact on technology in the last century. But how many more Alvarezes and Shockleys have we missed? Given the potential of scientific innovations to improve almost all aspects of modern life, missing just one is probably one too many.

About the author(s)

Gregory Park is a PhD student in the Department of Psychology and Human Development at Vanderbilt University. David Lubinski is professor of psychology and co-director of the Study of Mathematically Precocious Youth (SMPY) at Vanderbilt University. Camilla P. Benbow is Patricia and Rodes Hart Dean of Peabody College of Education and Human Development and co-director of SMPY at Vanderbilt University.

[Permalink: www.scientificamerican.com/article.cfm?id=recognizing-spatial-intel]

Picture This: Increasing Maths and Science Learning by Improving Spatial Thinking

The following article has been slightly adapted for a UK audience.

By Nora S. Newcombe

Nora S. Newcombe is a professor of psychology at Temple University and the principal investigator of the Spatial Intelligence and Learning Center (which is funded by the National Science Foundation). She has been a visiting professor at the University of Pennsylvania, Princeton University, and the Wissenschaftskolleg in Berlin. She is also a past president of the Developmental Psychology division of the American Psychological Association.

Albert Einstein's scientific accomplishments so impressed the world that his name is shorthand for intelligence, insight, and creativity. To be an Einstein is to be inconceivably brilliant, especially in maths and science. Yet Albert Einstein was famously late to talk, and he described his thinking processes as primarily non-verbal. 'The words or the language, as they are written or spoken, do not seem to play any role in my mechanism of thought,' he once said. '[There are] more or less clear images'.[1] Research on his brain, preserved after death, has seemed to support his claim of thinking in spatial images: Sandra Witelson, a neuroscientist in Canada, found that his parietal cortex, an area of the brain used for spatial and mathematical thinking, was unusually large and oddly configured,[2] and likely supported him in imagining the universe in innovative ways.

Einstein was unique, but he certainly was not the only scientist to depend on his ability to think spatially. Watson and Crick's discovery of the structure of DNA, for example, was centrally about fitting a three-dimensional spatial model to existing flat images of the molecule. The fact is, many people who work in the sciences rely on their ability to think spatially, even if they do not make grand discoveries. Geoscientists visualise the processes that affect the formation of the earth. Engineers anticipate how various forces may affect the design of a structure. And neurosurgeons draw on MRIs to visualise particular brain areas that may determine the outcome of a surgical procedure.

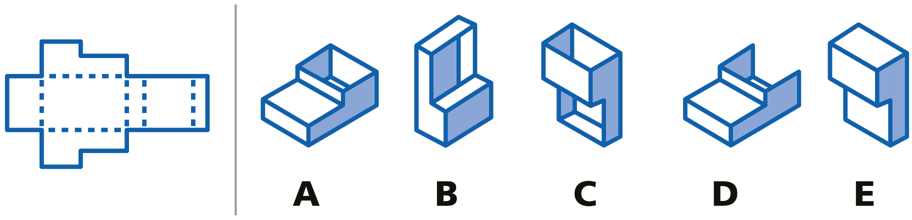
So, is spatial thinking really a key to science, technology, engineering, and mathematics – the so-called STEM disciplines? Yes. Scores of high quality studies conducted over the past 50 years indicate that spatial thinking is central to STEM success. One of the most important studies is called Project Talent; it followed approximately 400,000 people from their secondary school years in the late 1950s to today.[3] It found that people who had high scores on spatial tests in secondary school were much more likely to major in STEM disciplines and go into STEM

Tests of Spatial Thinking

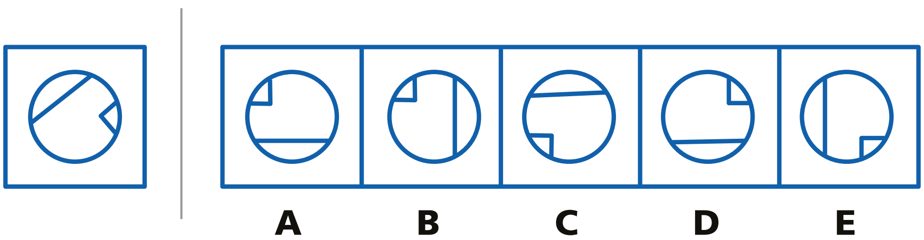
The following four tests were used in the Project Talent study. Here, each is briefly described and a sample item is provided. Answers for the sample items are given at the end of the article.

Editors

1. Three-dimensional spatial visualization: Each problem in this test has a drawing of a flat piece of metal at the left. At the right are shown five objects, only one of which might be made by folding the flat piece of metal along the dotted lines. You are to pick out the one of these five objects which shows just how the piece of flat metal will look when it is folded at the dotted lines. When it is folded, no piece of metal overlaps any other piece or is enclosed inside the object.



2. Two-dimensional spatial visualization: In this test each problem has one drawing at the left and five similar drawings to the right of it, but only one of the five drawings on the right exactly matches the drawing at the left if you turn it around. The rest of the drawings are backward even when they are turned around. For each problem in this test, choose the one drawing which, when turned around or rotated, is exactly like the basic drawing at the left.



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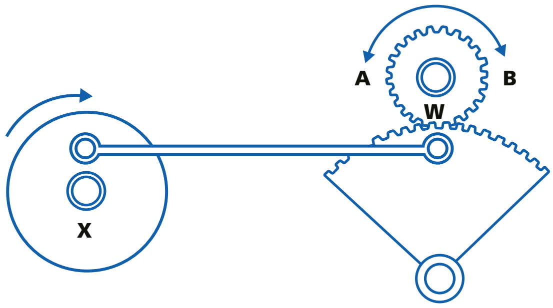
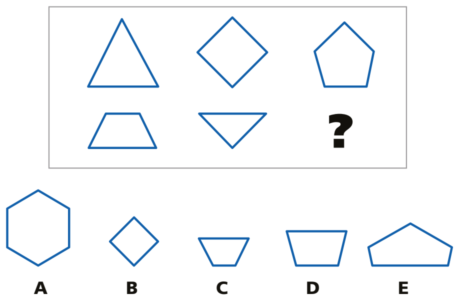
3. Mechanical reasoning: This is a test of your ability to understand mechanical ideas. You will have some diagrams or pictures with questions about them.
   For each problem, read the question, study the picture above it, and mark the letter of the answer on your answer sheet.



While wheel X turns round and round in the direction shown, wheel W turns

A. in direction A.
B. in direction B.
C. first in one direction and then in the other.

4. Abstract reasoning: Each item in this test consists of a set of figures arranged in a pattern, formed according to certain rules. In each problem you are to decide what figure belongs where the question mark is in the pattern.... The items have different kinds of patterns and different rules by which the drawings change.



careers than those with lower scores, even after accounting for the fact that they tended to have higher verbal and mathematical scores as well. Similar results have been found in other longitudinal studies: one began in the 1970s and tracked the careers of a sample of gifted students first studied in their early years at secondary school[4]; another began in the 1980s with observing the block play of preschoolers and followed their mathematics learning through secondary school.[5]

In short, the relation between spatial thinking and STEM is a robust one, emerging for ordinary students and for gifted students, for men and for women, and for people who grew up during different historical periods. Spatial thinkers are likely to be more interested in science and maths than less spatial thinkers, and are more likely to be good enough at STEM research to get advanced degrees.

So, would early attention to developing children's spatial thinking increase their achievement in maths and science, and even nudge them toward STEM careers? Recent research on teaching spatial thinking suggests the answer may be yes.

What Do We Mean by Spatial Thinking?

So far, we have been casual in using the term 'spatial thinking.' But what do we really mean by it? Spatial thinking concerns the locations of objects, their shapes, their relations to each other and the paths they take as they move. All of us think spatially in many everyday situations: when we consider rearranging the furniture in a room, when we assemble a bookcase using a diagram or when we relate a map to the road ahead of us. We also use spatial thinking to describe non-spatial situations, such as when we talk about being close to a goal or describe someone as an insider.

This general description is helpful but in conducting research, precise definitions are necessary. For the Project Talent study, spatial thinking was defined by the four tests used to assess it; a sample item from each of those four tests is shown in the box on page 13.[6] The first test asks us to imagine folding a two-dimensional shape into a three-dimensional one. The second asks us to mentally rotate a two-dimensional shape. The third asks us to imagine mechanical motion. The fourth asks us to see spatial patterns and progressions.

Tests like these four have been around for a century or so, and they remain useful assessments of spatial ability. But they do not cover the full range of abilities that fall under the term 'spatial thinking,' so today's researchers are working on developing new assessments. For example, one very different kind of spatial thinking involves navigating around the wider world. Many people think that, to get where we are heading, we need to be able to form a mental map of the environment.[7] It appears that some of us are much better than others at forming these integrated representations.[8] Spatial thinking of this kind may also be relevant to STEM success, but this idea has not yet been tested, largely because we lack good tests of navigation ability that can be given to large samples of students. Computer technology may soon allow such assessments.

To really understand what spatial thinking is, we must be clear about what it is not. First, spatial thinking is not a substitute for verbal or mathematical thinking. Those who succeed in STEM careers tend to be very good at all three kinds of thinking. Second, given the popularity of the notion that students have learning styles – i.e., that they are visual, auditory, or kinesthetic learners – it's important to understand that spatial thinking is not a learning style. The truth is that there is virtually no support for learning styles in the research literature. While students may have preferences, all of us (with very rare exceptions) learn by seeing, hearing, and doing.* Likewise, all of us (with very rare exceptions) think verbally, mathematically, and spatially. So teachers should be trying to provide students with the content knowledge, experiences, and skills that support development of all three ways of thinking.

Can Spatial Thinking Actually Be Improved?

Since spatial thinking is associated with skill and interest in STEM fields (as well as in other areas, such as art, graphic design, and architecture), the immediate question is whether it can be improved. Can we educate children in a way that would maximise their potential in this domain? Americans often believe that their abilities are fixed, perhaps even at birth;[9] it is not uncommon to hear that a person was born with a gift for mathematics or a difficulty in learning foreign languages. But there is mounting evidence that this is not the case.[10] Abilities grow when students, their parents, and their teachers believe that achievement follows consistent hard work and when anxiety about certain areas, such as maths, is kept low.†

What about spatial thinking in particular – is it malleable? Definitely. We have known for some time that primary school children's spatial

* Instead of tailoring lesson to students' supposed learning styles, teachers should be concerned with tailoring their lessons to the content (e.g., showing pictures when studying art and reading aloud when studying poetry). For a thorough explanation of this, see 'Do Visual, Auditory, and Kinesthetic Learners Need Visual, Auditory, and Kinesthetic Instruction?' by Daniel T. Willingham in the Summer 2005 issue of *American Educator*, available at www.aft.org/newspubs/periodicals/ae/issues.cfm.

† Summing up 30 years of research, Daniel T. Willingham wrote, 'Intelligence can be changed through sustained hard work.' For his explanation of the genetic and environmental influences on intelligence, see the sidebar on page 10 of the Spring 2009 issue of *American Educator*, available at www.aft.org/newspubs/periodicals/ae/issues.cfm.

thinking improves more over the school year than over the summer months.[11] A recent meta-analysis (which integrated the results of all the high quality studies of spatial malleability conducted over the past few decades) showed substantial improvements in spatial skill from a wide variety of interventions, including academic coursework, task-specific practice and playing computer games that require spatial thinking, such as Tetris (a game in which players rotate shapes to fit them together as they drop down the screen).[12] Furthermore, these improvements were durable, and transferred to other tasks and settings. For example, when undergraduates were given extended, semester-long practice on mental rotation, through taking the test repeatedly and also through weekly play of Tetris, training effects were massive in size, lasted several months, and generalised to other spatial tasks such as constructing three-dimensional images from two-dimensional displays.[13] Along similar lines, undergraduates who practised either mental rotation or paper folding daily, for three weeks, showed transfer of practice gains to novel test items, as well as transfer to the other spatial tasks they had not practised. [14] Spatial training has also been found to improve educational outcomes, such as helping college students complete engineering degrees.[15]

While many studies have found that spatial thinking can be improved, researchers have found some important differences between high and low ability participants. For low ability participants, there is an initial hump to get over. They improve slowly, if at all, for the first half-dozen or so sessions.** But if they persevere, faster improvement comes, so it's important that students (and teachers) not give up.[16] High ability participants do not have an initial hump, but they still can improve. Even people who are spatially proficient turn out to be not nearly as proficient as they could be, and they can attain even higher levels of excellence through fun activities like playing Tetris.[17] While playing Tetris may not fit into the school day, it might be offered in after-school settings or be suggested to students as a weekend or summer activity (in moderation, of course). (Other spatial thinking activities that fit better into academic studies, such as why the earth has seasons, are discussed later.)

In addition to practising spatial thinking tasks like those shown in the box on pages 17-18, well-conceived symbolic representations, analogies and gestures are also effective in improving one's spatial thinking ability. Let's discuss each of these briefly.

** Researchers are not sure why this is. It could be that those who are not good at spatial thinking have not yet developed mental strategies for dealing with spatial problems. So, in the initial stage when it appears that they are not improving, they could be developing and testing strategies. Then, once they have hit on an effective strategy, they start to improve and continue improving as they practice. In contrast, high-ability participants already have effective mental strategies and are simply becoming better through practice.

One of the distinctive characteristics of human beings is that they can use symbolic representations, such as language, maps, diagrams, sketches, and graphs. Spatial language is a powerful tool for spatial learning. Babies learn a spatial relation better when it is given a name,[18] preschoolers who understand spatial words like 'middle' perform better on spatial tasks than those who do not,[19] and preschool children whose parents use a greater number of spatial words (like outside, inside, under, over, around, and corner) show better growth in spatial thinking than children whose parents do not use such language.[20] Adults' spatial thinking is also enhanced by spatial language (e.g., the word parallel helps pick out an important spatial concept), as is their thinking about concepts, such as time, that are often described with spatial metaphors (e.g., far in the future).[21] Along similar lines, the ability to use maps can transform our thinking,[22] allowing us to draw conclusions that would be hard to arrive at without maps. A famous example is seeing the relation between drinking polluted water and getting cholera; in the 1800s, a map of water pumps in London superimposed on a map of cholera cases made the case for a relationship. Like maps, diagrams, sketches and graphs also allow us to make inferences by supporting our spatial thinking.[23] For example, a graph of how boys and girls change in height over childhood and adolescence shows us very clearly that, on average, girls have an earlier growth spurt and finish growing earlier.

In addition to being able to think symbolically, humans have a distinctive ability to think analogically, that is, to see relational similarities between one situation and another. People can learn through noticing analogies, that is, by comparing two situations and noting their common relational structure (as when we compare the structure of the atom to the structure of the solar system). This process facilitates learning in children,[24] including spatial learning,[25] mathematical insight,[26] and scientific reasoning.[27] Thus, an additional way to get children to develop spatial reasoning abilities is to point out and highlight key comparisons they should be making.

People also gesture as they think, and gesture has turned out to be not only a window into how thinking occurs,[28] but also a powerful tool for improving various kinds of learning. Gestures provide a window into learners' minds and offer information about whether a learner is ready to improve on a task.[29] But gesture can also play a more active role in

* [Instead of tailoring lesson to students' supposed learning styles, teachers should be concerned with tailoring their lessons to the content (e.g., showing pictures when studying art and reading aloud when studying poetry). For a thorough explanation of this, see 'Do Visual, Auditory, and Kinesthetic Learners Need Visual, Auditory, and Kinesthetic Instruction?' by Daniel T. Willingham in the Summer 2005 issue of American Educator, available at www.aft.org/newspubs/periodicals/ae/issues.cfm.]

† [Summing up 30 years of research, Daniel T. Willingham wrote, 'Intelligence can be changed through sustained hard work.' For his explanation of the genetic and environmental influences on intelligence, see the sidebar on page 10 of the Spring 2009 issue of American Educator, available at www.aft.org/newspubs/periodicals/ae/issues.cfm.]

learning, in two ways. First, when teachers use gesture in instruction, children often learn better than when taught with speech alone.[30] Second, when children gesture as they explain a problem, either prior to[31] or during[32] instruction, they learn better than if they do not gesture. Gesture is a powerful means of reflecting and communicating about spatial knowledge. Gesture has the potential to be a particularly powerful instructional tool in the spatial domain because it is particularly good at capturing spatial relationships among objects. For example, when talking about how the earth turns and revolves around the sun, teachers can gesture to capture those relationships.

Overall, our bag of tricks for enhancing spatial thinking is quite full. But there is more to learn. We know that practice, symbolic representations, analogies and gestures all improve spatial thinking, but we don't know which of these approaches is most effective. Teachers will have to use their best judgment and fit spatial thinking into the school day as best they can. To help, I offer some suggestions at the end of this article.

What About Gender Differences?

Gender differences are often the first thing people want to talk about when they consider spatial thinking. Three big questions usually come to mind: Do gender differences exist? If so, how big are they? What causes them – are they biological or environmental? Research has found gender differences in spatial thinking ability, both among average men and women, and among the very highest achievers. For some spatial tests, these differences are large. However, while these differences do exist, we need to remember that average gender differences do not tell us about individual performance – some girls have strong spatial skills and some boys are lacking these skills. Gender differences in spatial thinking are no barrier to women's success in the STEM disciplines as long as educators take the steps to ensure that all students, of both genders, acquire the spatial thinking skills they need.

The question about causes is a tricky one. The assumption behind this question is usually that, if biological, the difference is immutable, whereas if environmental, it could be reduced or even eradicated. There are two problems with the question, however. The first problem is with the assumption behind it: biological causation does not imply immutability and environmental causation does not guarantee changeability. The second problem is that we don't know the answer. A specially assembled team of experts with various takes on the problem recently concluded that there was evidence supporting both kinds of influences, with the additional possibility that the influences interacted (as when experience alters brain structures).[33]

Since spatial thinking can be improved, the important fact is not the causation of gender differences but the fact that girls (and boys) can improve. Some have suggested special training for females to help them catch up to males,[34] but as educators we want all students to do their best. That means we may not close the gap: meta-analyses have found that the genders generally improve in parallel and thus the gender difference continues even with training[35] (although some exceptions have been reported in which performance by men and women converged[36]). Nevertheless, even if the gap does not close, many women (and men) can and will come to perform well above threshold levels for success in the STEM disciplines, at which point other factors such as persistence, communication and creativity may be more important than spatial ability.

What Does This Mean for Teachers?

Since spatial cognition is malleable, spatial thinking can be fostered with the right kind of instruction and technology. As we have seen, spatial thinking improves during the school year more than over the summer months,[37] showing that teachers are helping students already. But what exactly should we be doing to help them improve even more? Unfortunately, precise answers are not yet possible. The National Academies' report Learning to Think Spatially pointed out that we still lack specific knowledge of what kinds of experiences lead to improvement, how to infuse spatial thinking across the curriculum, or whether (and how best) to use new technologies such as Geographic Information Systems, especially with young children. What kinds of teaching best support spatial learning? Are these kinds of teaching different at different ages, at different socioeconomic status levels, or for girls and boys? Developing and testing curricula in a scientific way can be a slow process, and much remains to be done to be absolutely sure of our ground. However, we are beginning to have some good ideas about where to start, especially with preschool and primary school students.

1 **Teachers (and parents) need to understand what spatial thinking is, and what kinds of pedagogical activities and materials support its development.** Recall that spatial thinking involves noticing and remembering the locations of objects and their shapes and being able to mentally manipulate those shapes and track their paths as they move. Because spatial thinking is not a subject, not something in which children are explicitly tested, it often gets lost among reading, mathematics and all the other content and skills specified in state standards. Teachers need to be able to recognize where they can infuse it into the school day. For example, teachers could use the cardinal directions (north, south, east and west) to talk about how to get to the cafeteria or playground, or use words like parallel and perpendicular when possible.

2 **Teachers at all levels need to avoid infusing students with anxiety about spatial tasks.** In general, anxiety about doing a task can impede performance, at least in part by occupying valuable mental space in working memory.[38] When you spend a lot of time worrying that you won't do well, you lack the cognitive resources to actually concentrate on the work, a sad example of a self-fulfilling prophecy. Research with 6- to 8-year-olds in the Chicago Public Schools has recently shown that this vicious circle is evident for spatial thinking as well as for other areas like maths: children who worry about not doing well perform more poorly than children who do not have such anxiety.[39] Thus, as is also true for other areas in teaching, teachers should avoid presenting spatial tasks as difficult challenges on which some people may not do well, or presenting students' performance on these tasks as indicative of their underlying spatial abilities. Instead, teachers should emphasize that the tasks can be enjoyable and useful, and that they can be mastered with some effort and time.

3 **In the preschool years, teachers (and parents) need to encourage, support and model engagement in age-appropriate spatial activities of a playful nature.** Preschool children need a good balance of play and formal instruction.[40] Fortunately, there is a wealth of spatial material available for preschool play, much of which can be further leveraged by a teacher with knowledge of the processes of spatial learning. Here are some specific ideas that could fit into most preschool settings:

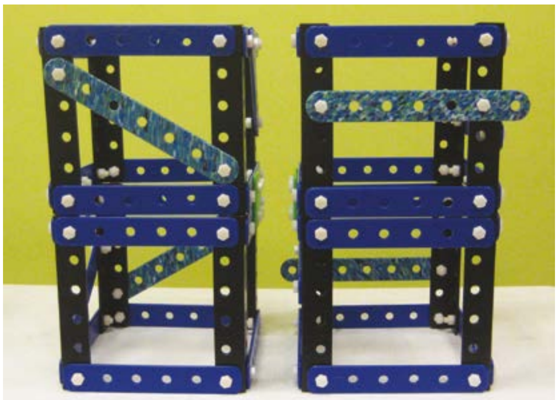
- Select spatially challenging books for young children. For example, *Zoom* [41] is a book in which attention continually zooms in to finer and finer levels of detail. Verbal and gestural support for children in dealing with the book's conceptual and graphic challenges is correlated with children's scores on spatial tests.[42]

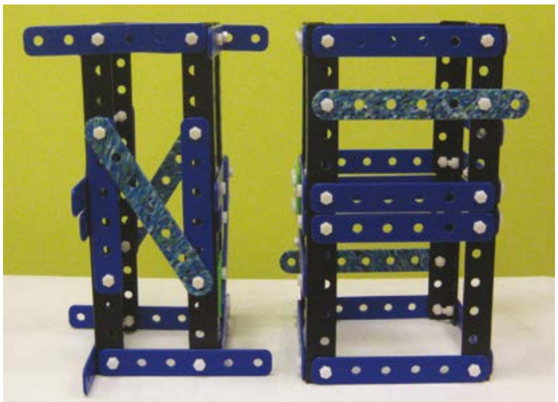
- Use odd-looking as well as standard examples when teaching the names of geometric shapes such as circle, square and triangle (e.g. a tipped, skinny, scalene triangle as well as an equilateral triangle pointing up). Showing these kinds of shapes supports learning that triangles are any closed figure formed by three intersecting straight lines.[43]

- Teach spatial words such as out, in, outside, inside, middle, between, here, there, front, back, side, top, bottom, up, down, under, over, around, tall, high, short, low, line (it) up, row, next (to) and corner. Learning spatial words can be enhanced by using gestures that highlight the spatial properties being discussed.[44]

- Encourage young children to gesture. Research has found that when children are asked whether two shapes can be fitted together to make another shape, they do significantly better when encouraged to move their hands to indicate the movements that would be made in pushing the shapes together.[45] Some children do this spontaneously, but children who do not will perform better when asked to gesture.

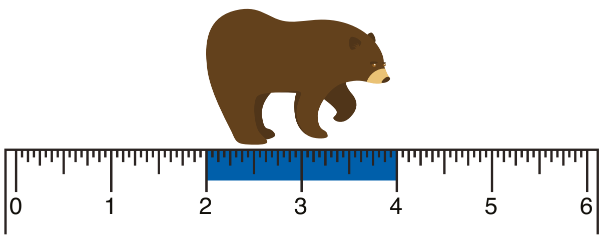
- Ask children to imagine where things will go in simple 'experiments.' For example, preschoolers are prone to think that dropped objects will appear directly below where they were released, even when they are dropped into a twisting tube with an exit point far away. But, when asked to visualise the path before responding, they do much better. Simply being asked to wait before answering does not help – visualization is key.[46]
- Do jigsaw puzzles with children; they have been found to predict good spatial thinking, especially when coupled with spatial language (e.g., *Can you find all the pieces with a flat edge?*).[47] Similarly, play with blocks is a great activity in itself, and it increases use of spatial language.[48]
- Use maps and models of the world with children as young as 3.[49]
- Develop analogies to help young children learn scientific ideas, such as the principle of how a brace supports a building.[50] Consider the two photos below. In the one on top, comparing the two structures is relatively easy because the only difference is whether the brace is diagonal or horizontal, but on the bottom the comparison is more difficult because the two structures differ in several ways. When children shake these structures to see how much they wiggle, they are much more likely to conclude that a diagonal piece increases stability when interacting with the display on top.



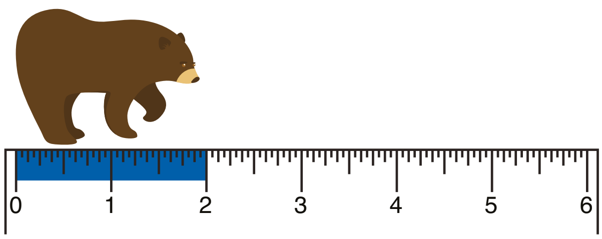


4 **In the primary school years, teachers need to supplement the kinds of activities appropriate for preschoolers with more focused instruction in spatial thinking.** Playful learning of the sort that occurs in preschool can continue to some extent in primary school; activities such as block building, gesturing, reading spatially challenging books, etc., continue to develop spatial skills in older children too.[51] But as children get older, they can also benefit from more focused lessons. Mathematics is a central subject in which spatial thinking is needed, because space provides a concrete grounding for number ideas, as when we use a number line, use base-10 blocks, or represent multiplication as area. Here are some specific ideas for children in nursery through Y6/7:

- Highlight spatial elements in mathematics lessons. Measurement, for example, can be difficult for children to master, especially when the object to be measured is not aligned with the end of a ruler. Children often make mistakes such as counting hash marks beginning with 1, thus getting an answer that is one unit too many. When teaching measurement in early primary, teachers can consider using a technique in which the unit between hash marks on a ruler is highlighted as the unit of measurement.[52] As shown in the illustration below, children can work with small unit markers coordinated with larger pieces to highlight how to determine units.



1 Measure the object so that it is not aligned with the beginning of the ruler. Place opaque unit pieces below the object to measure how long it is.



2 Move the object back to the beginning of the ruler and use the unit pieces to 'check' the answer.

- Add mapping skills, when possible, to geography lesson for older primary students. Some ideas can be found in Phil Gersmehl's book, *Teaching Geography*, which is based in part on cognitive science.[53]

- Use well-crafted analogies so that comparisons will highlight essential similarities and differences. For example, students can compare diagrams of animal and plant cells to see similarities and differences.[54]

- Ask children from around the ages of 9 to 14 to make sketches to elaborate on their understanding of topics such as states of matter, or force and motion.[55] For example, they can be asked to draw water molecules in the form of ice, liquid, or vapor.
- Suggest beneficial recreational activities, such as photography lessons (to develop a sense of shifting viewpoints and changes in scale[56]), origami (to deepen their knowledge and skill in combining shapes) and JavaGami[57] (software for creating polyhedra) and video games like Tetris.[58]

Spatial thinking is important, probably as important as verbal and mathematical thinking, for success in science, technology, engineering and mathematics. Furthermore, it can be taught and something we do in schools is already associated with improving it. Yet we can do better. The need to develop students' spatial thinking is currently not widely understood. We already have some excellent techniques for developing it, through practice, language, gesture, maps, diagrams, sketching and analogy. Systematically building these techniques into the curriculum could yield important dividends for education.

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The Middle Child: Analysing Data in an EAL Context

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The importance of maintaining a focus on literacy within the curriculum has never been far away from the government's agenda and anyone working within education would agree that developing strong literacy skills are key to a student's success, particularly as external examinations consist of written papers.

Despite this, incorporating effective literacy strategies into a lesson can, at times, be challenging particularly if staff do not have clear data informing them of each student's literacy capabilities. Furthermore, for some teachers, teaching literacy effectively within their lessons, especially those which are not literacy based, may not be an area of expertise. However, our classrooms are becoming progressively more globalised with increasing numbers of students having English as an Additional Language (EAL).

Some of these students are quickly identified for extra support as they present with very low levels of language acquisition; often these students are then tested further to establish specific areas of need and teachers are then provided with increased information and data to effectively differentiate their teaching which ensures these students make good progress. However, the majority of EAL students, in an international school environment, present with a good level of speaking and listening skills; they effectively communicate within the classroom and actively participate in learning activities. These students rarely raise concerns or are considered to be underachieving, particularly if their attitude to learning is good.

Should the Cognitive Abilities Test (*CAT4*) or a similar aptitude test, be completed these students will often sit within stanines 4-7 for their overall *CAT4* score, results which are seen to confirm the fact that they are cognitively able and do not require extra support for literacy. Closer analysis of the *CAT4* batteries can however reveal a very different picture.

Analysing *CAT4* data from cohorts of primary and secondary students in two international schools in differing areas of the world, most if not all students with EAL have a significant verbal deficit (the difference between their standardised age score for the verbal and non-verbal batteries, any deficit larger than minus 10 being statistically significant). It is crucial that literacy development is a key focus in every lesson for students with a deficit of minus 10 or more if they are to achieve their very best across the curriculum. Therefore, every teacher must be or become a confident teacher of both their subject area and literacy, even if their subject is not literacy based.

When these students are further tested with the New Group Reading Test many of them often have good comprehension skills but significantly weaker word knowledge and vocabulary skills. This in practice means they can comprehend and rote learn information but lack the depth and breadth of vocabulary, in particular subject specific technical vocabulary, to explain in their own words what they have learned. This inhibits them from cognitively processing new information in a manner reflective of their non-verbal score which can reduce their ability to engage higher order thinking skills and therefore limit their progress and achievement. Furthermore, unless explicitly taught, grammar skills may also be lacking especially in older students who joined secondary school with little English.

Compounding these issues are the increasingly complex academic demands students face as they move through school and unless schools address the verbal deficit and close the literacy gap students with a verbal deficit will often struggle and underachieve. Notably, at first glance many of these students appear to be achieving good academic grades, but teachers should understand that if their verbal deficit is addressed much higher academic success is possible, particularly in the later stages of their education, university and beyond.

So what can we do? Very often it is as simple as making the implicit explicit. We need to explicitly teach literacy skills in context when the opportunity arises in the classroom. To name but a few:

- Consistently applying the school's marking for literacy policy and giving students the opportunity to improve their writing when they have made mistakes;
- Explicitly teaching reading strategies such as skimming and scanning and taking time to teach students how to use diagrams, pictures, headings and topic sentences in text books to gather meaning and identify key points and ideas;
- Explicitly teaching writing strategies that are important for your subject such as effective note taking or writing a practical report in science;
- Always providing and referring to key word glossaries and giving opportunities for the use of technical language to be practiced;
- Scaffolding writing activities for students and incorporating opportunities to use writing strategies such as Point, Evidence, Explain wherever possible;

- Providing explicit success criteria for writing; presenting students with information in a variety of styles, e.g. research papers or more advanced text books and teaching information gathering strategies and encouraging the use of talk partners and providing scaffolds such as 'Thought Stems' to enable students to effectively discuss and clarify their ideas with a partner before writing them down.

If we provide teaching staff with key data with which to identify their students' literacy needs and provide professional development to arm them with a number of tools to effectively teach literacy within all subjects, we can enable all teachers to become effective teachers of literacy. This, I believe, is one of the key components required to ensure every student realises their true potential and an important investment in the future of our young people.