



**Evidence for
Excellence in
Education**

**PISA in Practice:
What can we Learn From England's High
Performance in Science and Problem-solving?**

Foreword

The OECD Programme for International Student Assessment (PISA) is used by governments around the world to compare results of differing education policies and provides a wealth of information that informs educational policy.

Yet this evidence is not the sole preserve of policy makers. In-depth analysis of the PISA data can help inform practitioners and school leaders about factors relating to pupil achievement. Such analysis can, for example, provide robust useful evidence about specific pupil characteristics, attitudes and behaviours that are related to high achievement in PISA.

It is not enough, though, to simply identify where such relationships exist – it is important to reflect on how practitioners can adapt their practice to maximise the potential of all pupils no matter what their ability.

In this series, commissioned by the Department for Education (DfE), we showcase some findings from PISA that teachers can use in the classroom.

This report focuses on England's performance in PISA 2012. It explores the characteristics of those pupils who were high performers in the PISA science and problem-solving assessments, and identifies strategies for helping to develop the behaviours and attitudes associated with high performance in all pupils.

PISA 2012 in England was conducted by NFER on behalf of the DfE. The national report for England can be accessed at <https://www.gov.uk/government/publications/programme-for-international-student-assessment-pisa-2012-national-report-for-england> and the international reports at <http://www.OECD.org/PISA>

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Overview

What can PISA tell us?

PISA is the world's biggest international pupil assessment involving 15-year-olds in over 60 countries. In 2012 it assessed maths, reading, science and problem-solving. PISA is a key source of information on pupil performance measured independently of national curricula and assessment frameworks. It also enables countries to compare performance internationally, which provides information above and beyond that from existing national assessments. The findings from PISA allow us to:

- compare our achievement across a number of subject domains with other countries, including both high and low achieving countries
- compare our achievement in a domain such as problem-solving, which is not assessed nationally
- explore England's performance across the ability range and compare this with other countries
- identify our strengths across the subject domains and compare these with what is seen internationally
- combine information about achievement with information about pupil characteristics and attitudes
- identify some of the background characteristics associated with high achievement, such as levels of engagement, and establish if these relationships are true in all subject domains.

How did pupils in England perform in the PISA science and problem-solving assessments in 2012?

England's performance in science and problem-solving was better than our performance in maths and reading. The average science and problem-solving performance of a 15 year old in England in 2012 was significantly better than that of an average 15 year old across all OECD countries¹. Of the 65 countries that participated in PISA 2012, a relatively small number of countries significantly outperformed England in science (ten countries in total). A smaller number of countries (44) participated in the PISA problem-solving assessment and, of those, only seven significantly outperformed England. In both subjects the countries that outperformed England included the high performing East and South East Asian countries.

In this report, pupils are categorised as **high performers** if they achieved PISA Level 5 or Level 6 (see below). In England, ten per cent of pupils achieved Level 5 and a further two per cent achieved Level 6 in the science assessment in 2012. For problem-solving, the percentage of high achieving pupils was slightly higher, with 11 per cent achieving Level 5 and three per cent achieving Level 6. For both science and problem-solving England has a greater number of high performers compared with the OECD average². Figures 1 and 2 below show the percentage of pupils in England and internationally at each of the PISA proficiency levels for science and problem-solving.

¹ There are 34 OECD countries; a full list can be found here: <http://www.oecd.org/about/membersandpartners/list-oecd-member-countries.htm>

² This refers to the OECD average. This is the mean of the data values for all OECD countries for which data is available or can be estimated. The OECD average can be used to see how a country compares on a given indicator with a typical OECD country (OECD, 2005).

Figure 1 Percentage of pupils at each of the PISA science proficiency levels

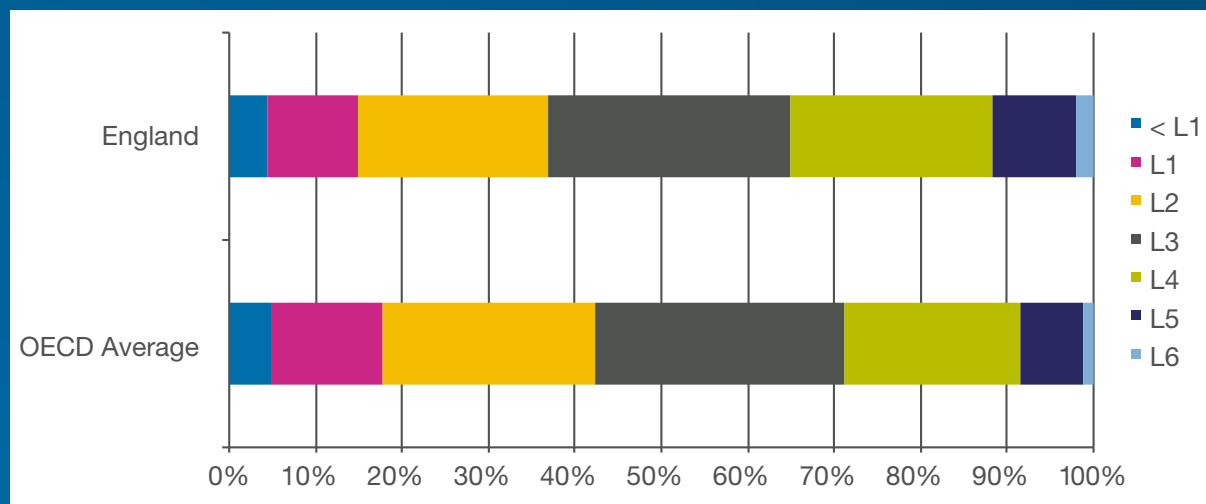
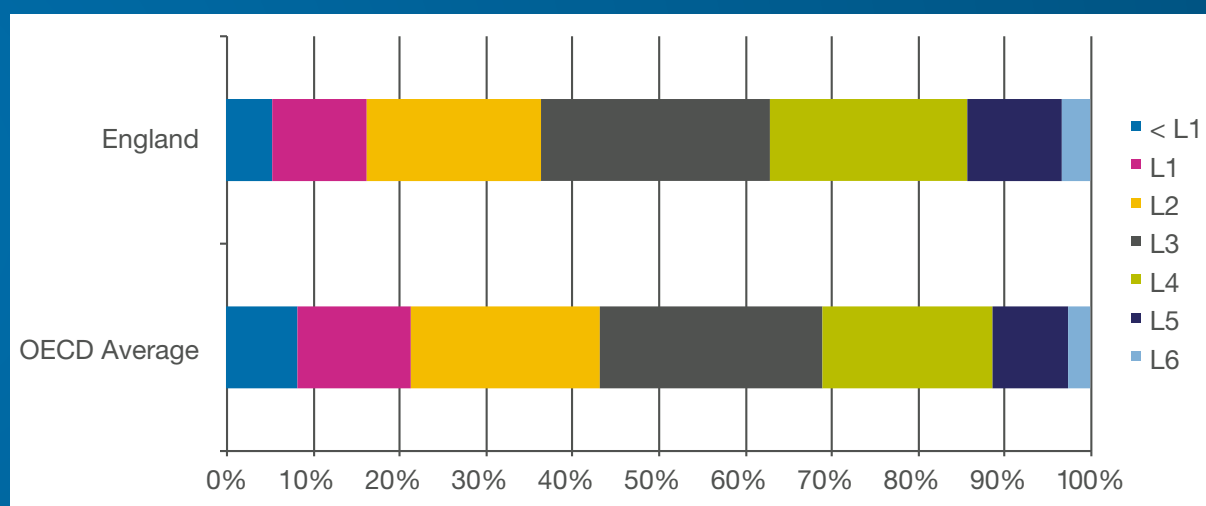


Figure 2 Percentage of pupils at each of the PISA problem-solving proficiency levels



In terms of pupil ability, this means that, in both science and problem-solving, over ten per cent of pupils in England are able to answer some of the most demanding PISA questions requiring them to perform complex tasks on what might be unfamiliar topics. This compares favourably with the highest performing countries. For science, only in six other countries world-wide³ were a higher proportion of pupils able to answer these challenging questions. Similarly for problem-solving, only in seven other countries world-wide⁴ were a higher proportion of pupils achieving the highest PISA levels. Contrary to England, these countries are also top performers in maths and reading, and some have a notably large group of pupils who are high performers across a number of the PISA subjects. In Shanghai, for example, nearly 20 per cent of pupils are high performers in science, maths and reading. Table 1 highlights the specific science and problem-solving abilities typically demonstrated by pupils who achieve Level 5 and Level 6 in these subjects.

³ Shanghai, Hong Kong, Singapore, Japan, Finland and Estonia.

⁴ Singapore, Korea, Japan, Macao-China, Hong Kong, Shanghai and Chinese Taipei

Table 1 Typical science and problem-solving abilities of pupils at PISA proficiency Level 5 and Level 6

	What pupils can typically do in the PISA science assessment	What pupils can typically do in the PISA problem-solving assessment
Level 5	<ul style="list-style-type: none"> Identify the scientific components of many complex life situations and apply both scientific concepts and knowledge. Compare, select and evaluate appropriate scientific evidence. Use well-developed inquiry abilities and construct explanations based on evidence. 	<ul style="list-style-type: none"> Systematically explore a complex problem scenario to gain an understanding of how relevant information is structured. Think ahead to find the best strategy that addresses all the given constraints. Adjust their plans or backtrack when they detect unexpected difficulties or when they make mistakes that take them off course.
Level 6	<p>Abilities of proficiency Level 5, plus:</p> <ul style="list-style-type: none"> Demonstrate advanced scientific thinking and reasoning, and use scientific understanding in support of solutions to unfamiliar scientific and technological situations. Use scientific knowledge and develop arguments in support of recommendations and decisions that centre on personal, social or global situations. 	<ul style="list-style-type: none"> Explore a scenario in a highly strategic manner to understand all information pertaining to the problem. Develop complete, coherent mental models of diverse problem scenarios, enabling them to solve complex problems efficiently. Modify their strategies, taking all constraints into account, both explicit and implicit.

Source: OECD (2013a)

Who are the high performers on the PISA science and problem-solving assessment in England?

A number of background characteristics are related to the likelihood of a pupil being a high performer in PISA and these characteristics are similar for science and problem-solving. For science, the findings from PISA generally mirror what is seen nationally, although there are some differences in relation to gender⁵. Direct comparisons for problem-solving are not possible as, in England, there is no national problem-solving assessment.

Pupils with the following background characteristics are more likely to be high performers in the PISA science and problem-solving assessments:

- pupils from less disadvantaged backgrounds and pupils attending schools with lower proportions of pupils eligible for free school meals (FSM) (nationally, at GCSE pupils known to be eligible for FSM perform less well)

5 The national attainment data is based on the percentage of pupils achieving the English Baccalaureate (this includes GCSE in core and additional sciences) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/280689/SFR05_2014_Text_FINAL.pdf

- pupils without special educational needs (SEN) (nationally, at GCSE pupils known to have SEN perform less well)
- boys – only in science (although, at GCSE, girls outperform boys in science with a higher percentage achieving five GCSEs A*–C)
- pupils of Chinese origin – only in problem-solving (at GCSE Chinese pupils are the highest attaining ethnic group).

PISA provides us with a valuable source of information about our high performers, over and above our existing national data. The PISA Student Questionnaire, for example, collects information on pupil attitudes and behaviours and provides an insight into engagement in school and attitudes to learning. As this type of information is not collected alongside national achievement data, PISA offers us insights into those aspects of pupil character that might be associated with high performers, which would not be possible when looking at purely national data. Together with the results from the PISA science and problem-solving assessments, this questionnaire data tells us more about the engagement and attitudes of pupils who perform at the highest levels.

- Pupils who report that they are on time for lessons or do not skip whole classes or days perform better, on average, than their peers in science and problem-solving.
- Pupils with more positive attitudes towards their school are more likely to be high performers in science and problem-solving in PISA 2012.
- Pupils with a lower sense of belonging at school are more likely to be high performers in science and problem-solving in PISA 2012.

Overall, the characteristics associated with the likelihood of high performance in science and problem-solving are also associated with the likelihood of being a higher performer in maths and reading. Although, the association between gender and the likelihood of being a high performer differs across subjects.

How can I engage all my pupils in their learning?

The characteristics highlighted above indicate that, in England, high performers are more engaged. The evidence from PISA shows that good attendance and a positive attitude towards school (key aspects of pupil engagement) are strong indicators of the likelihood of being a high performer. The OECD has also found that teacher practices have an important role to play in promoting engagement with school and learning (OECD, 2013a).

Teachers and school leaders will consequently want to consider the strategies they can adopt to increase or maintain, the engagement of all pupils. Section 4 of this report includes examples of effective engagement strategies (some of which are specifically focused on science), which have been suggested by a number of independent consultants and members of the Association for Achievement and Improvement through Assessment (AAIA) who have volunteered the findings from their action research projects to complement the PISA findings. These strategies aim to maximise and enhance pupil engagement in their learning and provide the best possible opportunities for successful, active learning to take place. Although not aimed specifically at developing the behaviours and attitudes highlighted above, they do provide useful suggestions as to what teachers and school leaders might do to engage learners and therefore maintain relatively high science and problem-solving performance. Some of the suggestions below focus on science; others are more generic and could be applied across subjects.

Ten key engagement strategies

- ✓ Focus on activities set in real-life contexts and think of ways of relating learning to pupils' lives. This will help pupils to see how what they are learning will be useful now and in the future – this is particularly important for science.
- ✓ Invest time planning how to introduce a topic to your class – try starting a new topic with exploratory discussions with your pupils.
- ✓ Design tasks that are more open ended and allow pupils to use their initiative and be creative in their learning, rather than purely setting tasks where you provide pupils with the 'right' answer.
- ✓ Build in enrichment activities at the end of a topic. In that way pupils who are particularly keen to learn more about the topic can gain ownership of their learning.
- ✓ Make time for de-briefing sessions to establish what interests your pupils and invite your pupils to ask questions that might be addressed in future lessons.
- ✓ Make pupil engagement an important focus across the whole school by, for example, appointing 'learner engagement champions' and including engagement as a standing item on the agenda of whole-staff meetings.
- ✓ Identify a range of engagement strategies, based on research and staff experience, and provide opportunities for teachers to feed back on the engagement strategies they have tried and exchange ideas on alternative strategies.
- ✓ Establish teacher learning communities or lesson study groups within the school so that teachers can observe their peers and share effective practice.
- ✓ Support teachers to take up professional development opportunities – teachers with updated knowledge may be better equipped to encourage pupils' learning.
- ✓ Consider establishing links with employers to help pupils to see the links between their learning and future job opportunities. This can be particularly important for science where the links between learning and job opportunities may not be so obvious for pupils.



1 Introduction: England's performance in PISA 2012

The Programme for International Student Assessment (PISA) is the world's biggest international pupil assessment, involving schools and pupils in over 60 countries. It was developed jointly by member countries of the Organisation for Economic Co-operation and Development (OECD) and assesses pupils in mathematical literacy, science literacy and reading literacy. A fundamental part of the definition of these concepts is that they go beyond school curricula and assess pupils in the context of real-life challenges. This inevitably involves finding solutions to problems and, in 2012, pupils were also assessed specifically on their problem-solving skills. As problem-solving is not assessed nationally, PISA provides vital information on how well pupils in England are able to confront and solve the types of problems that are encountered in everyday life. The specific assessment of 'problem-solving' in PISA 2012 contrasts with the assessments of maths, science and reading in that the content of the problem-solving questions is not related to specific areas of the curriculum. The problem-solving scenarios continue to reflect real-life contexts, but without the specific subject skills needed to answer the question.

PISA not only compares the ability of pupils in England with other countries around the world but also allows us to compare how pupils perform in each of the subjects assessed in PISA. This report focuses on: England's achievement in the science and problem-solving assessments, the links between pupil performance and their attitudes and behaviours and strategies that teachers might use to maintain our relatively high performance in these subjects.

1.1 England's performance in science

PISA measures the scientific understanding needed in adult life rather than simply measuring science as it may be defined within the curriculum of participating countries. PISA defines this as the capacity to identify questions, acquire new knowledge, explain scientific phenomena and draw evidence-based conclusions about science-related issues (OECD, 2013a). As a result, the PISA science assessment measures not only scientific knowledge, but also scientific competencies and understanding of scientific contexts.

Over 60 countries participated in the PISA science assessment in 2012 and average performance in England was significantly above the OECD average⁶. Pupils significantly outperformed those in many other EU and OECD countries. Only ten countries outperformed England in the PISA science assessment in 2012. These included high-achieving East and South East Asian countries and three EU countries (Finland, Estonia and Poland). England's performance in science has remained stable since 2006.

Results for England also showed a significant gender difference in favour of boys – that is boys performed better than girls. This differs from GCSE science results for the same cohort where, on the whole, boys and girls perform similarly.

⁶ This refers to the OECD average. This is the mean of the data values for all OECD countries for which data is available or can be estimated. The OECD average can be used to see how a country compares on a given indicator with a typical OECD country (OECD, 2005).

How does OECD define scientific literacy?

- Scientific knowledge and use of that knowledge to identify questions, acquire new knowledge, explain scientific phenomena and draw evidence-based conclusions about science-related issues.
- Understanding of the characteristic features of science as a form of human knowledge and enquiry.
- Awareness of how science and technology shape our material, intellectual and cultural environments.
- Willingness to engage in science-related issues, and with the ideas of science, as a reflective citizen.

1.2 England's performance in problem-solving

The assessment of problem-solving was re-introduced to PISA for 2012 as a computer-based assessment (it was previously assessed in PISA 2003 as part of the paper-based assessment).

Forty-four countries participated in the PISA problem-solving assessment in 2012 (within the UK only England took part). England's pupils performed significantly better than the OECD average⁷. Only seven countries outperformed England. These seven countries were all East and South East Asian countries/economies and were countries that also outperformed England in PISA 2012 in maths and reading. In England pupils perform significantly better in problem-solving, on average, than pupils in countries who show a similar performance to England in reading maths and science (OECD, 2014b).

In PISA the problem-solving tasks are classified as either 'static' or 'interactive'. The difference reflects whether the information needed to solve the problem is available when the pupil starts the task (static), or whether important pieces of information are found as the pupil works through the task (interactive). In England, pupils had a similar performance on both types of task.

The problem-solving tasks are also classified according to the problem-solving processes that a pupil uses. These are:

- exploring and understanding the information provided with the problem
- representing and formulating: constructing graphical, tabular, symbolic or verbal representations of the problem situation and formulating hypotheses about the relevant factors and relationships between them

How does OECD define and measure problem-solving?

... an individual's capacity to engage in cognitive processing to understand and resolve problem situations where a method of solution is not immediately obvious. It includes the willingness to engage with such situations in order to achieve one's potential as a constructive and reflective citizen.
(OECD, 2013)

⁷ This is the mean of the data values for all OECD countries for which data is available or can be estimated. The OECD average can be used to see how a country compares on a given indicator with a typical OECD country (OECD, 2005).

- planning and executing: devising a plan by setting goals and sub-goals, and executing the sequential steps identified in the plan
- monitoring and reflecting: monitoring progress, reacting to feedback, and reflecting on the solution, the information provided with the problem, or the strategy adopted.

Pupils in England performed best at monitoring and reflecting tasks, doing slightly less well on the other three problem-solving processes. In those countries outperforming England, pupils showed a higher level of proficiency on exploring and understanding and representing and formulating tasks compared with lower performing countries. This could indicate that pupils in the high-performing East Asian countries are skilled, in particular, at finding the information they need to solve problems.

1.2.1 Relationships between problem-solving and maths, science and reading

The PISA problem-solving assessments are designed to be answered without relying on curriculum-based knowledge. It was consequently expected that high scores on problem-solving tasks would be related to high scores on the other PISA subject areas because, in PISA maths, science and reading, pupils are assessed through items reflecting real-life contexts rather than curriculum-based knowledge. In England and internationally, maths is the subject most closely related to problem-solving; reading is the least closely-related subject. However the relationship between problem-solving and maths, science and reading is less strong than the relationship between the three subjects.



1.3 Identifying the high performers in science and problem-solving

In addition to knowing how well pupils in England perform on average, it is also important for the purposes of teaching and learning, to examine the spread in performance between the most and least able pupils. One way of doing this is to look at England's performance at each of the six PISA proficiency levels. The proficiency levels describe the types of skills learners are likely to demonstrate and the tasks that they are able to complete (OECD, 2014a). Test questions that focus on simple tasks and involve familiar contexts where all relevant information is present are categorised at lower levels. Questions that are more demanding, as they require pupils to perform complex tasks on unfamiliar topics, are categorised at higher levels.

Based on these proficiency levels, pupils have been categorised as high performers if they achieved PISA Level 5 and Level 6 (the highest PISA proficiency levels). Figures 3 and 4 give an overview of what pupils at proficiency Levels 5 and 6 can typically do in science and problem-solving.

Figure 3 Typical science abilities of pupils at PISA proficiency Level 5 and Level 6 (source: OECD, 2013a)

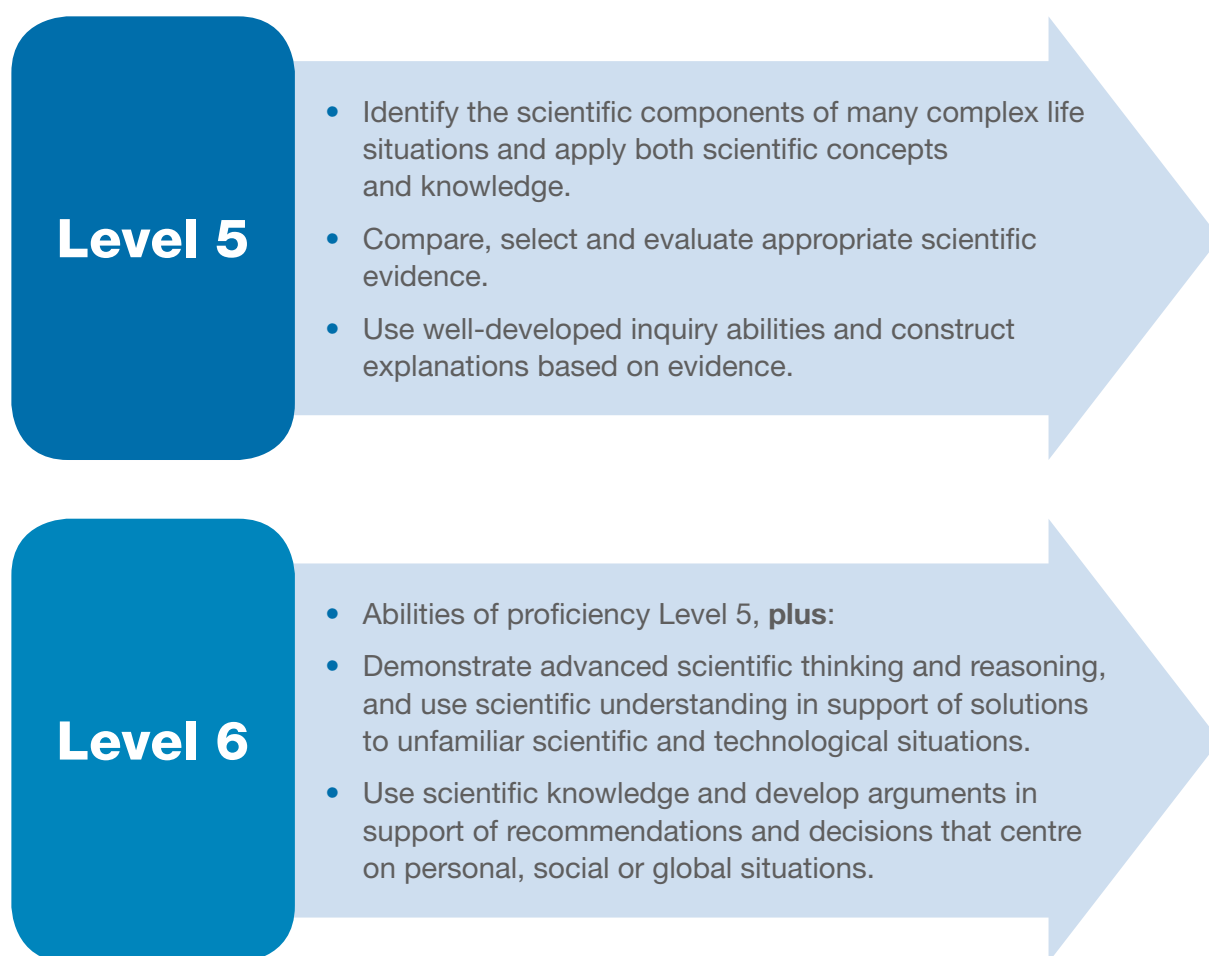
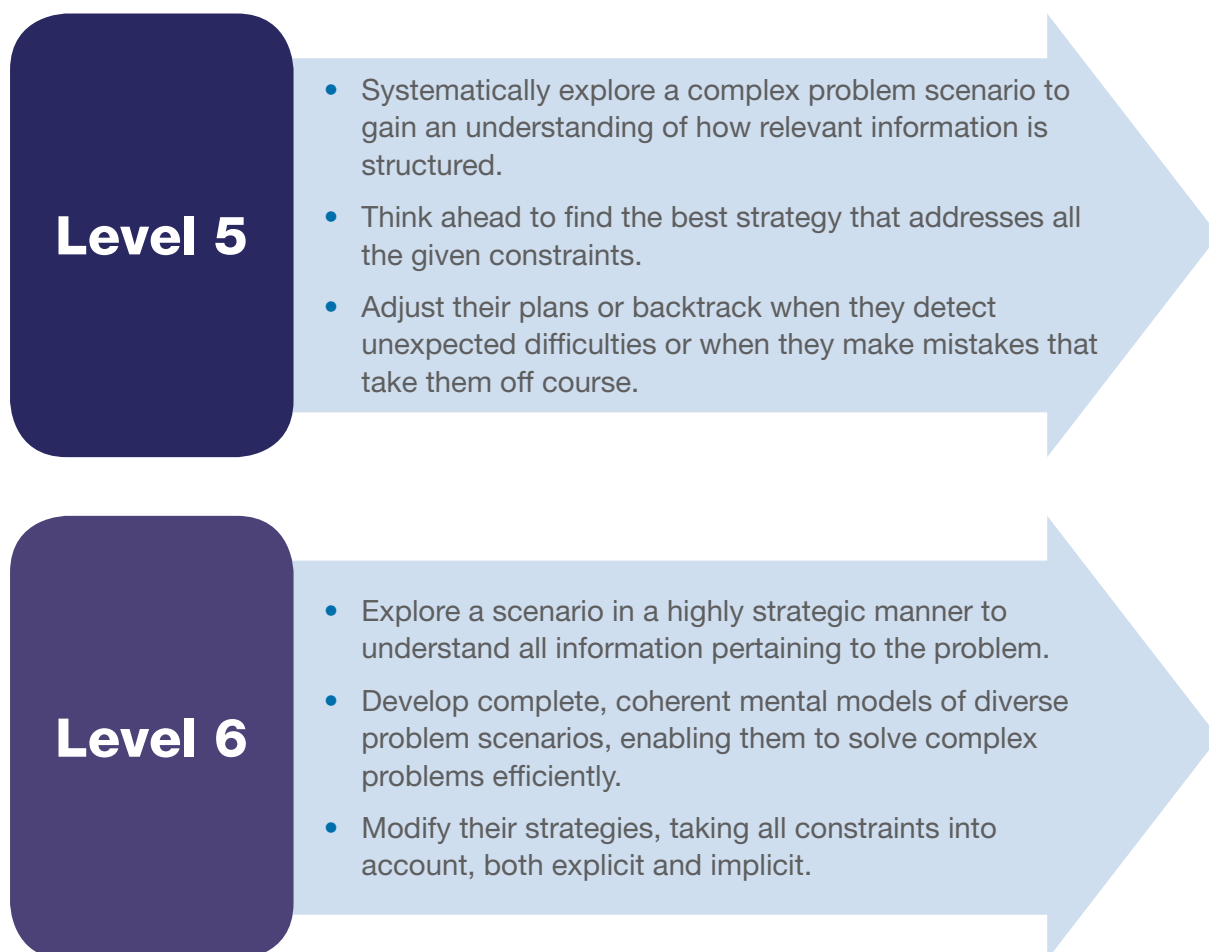


Figure 4 Typical problem-solving abilities of pupils at PISA proficiency Level 5 and Level 6 (source: OECD, 2013a)



In England, ten per cent of pupils achieved Level 5 and a further two per cent of pupils achieved Level 6, in science. If we look at problem-solving, the percentage of high performers is similar, with 11 per cent of pupils achieving Level 5 and a further three per cent achieving Level 6. For both subjects, the percentage of higher performers is higher than the average across the participating countries and a similar percentage to some of the highest performing countries. However, compared with the highest achieving East and South East Asian countries, England has a smaller percentage of higher performers and a much higher percentage of low performers. For example, in Singapore, the top-performing country in problem-solving, approximately 30 per cent of pupils are high performers and only eight per cent are low performers (Level 1 or below). Figures 5 and 6 below show the percentage of pupils, in England and the highest achieving countries, at each of the PISA proficiency levels for science and problem-solving.

Figure 5 Percentage of pupils at each of the PISA science proficiency levels

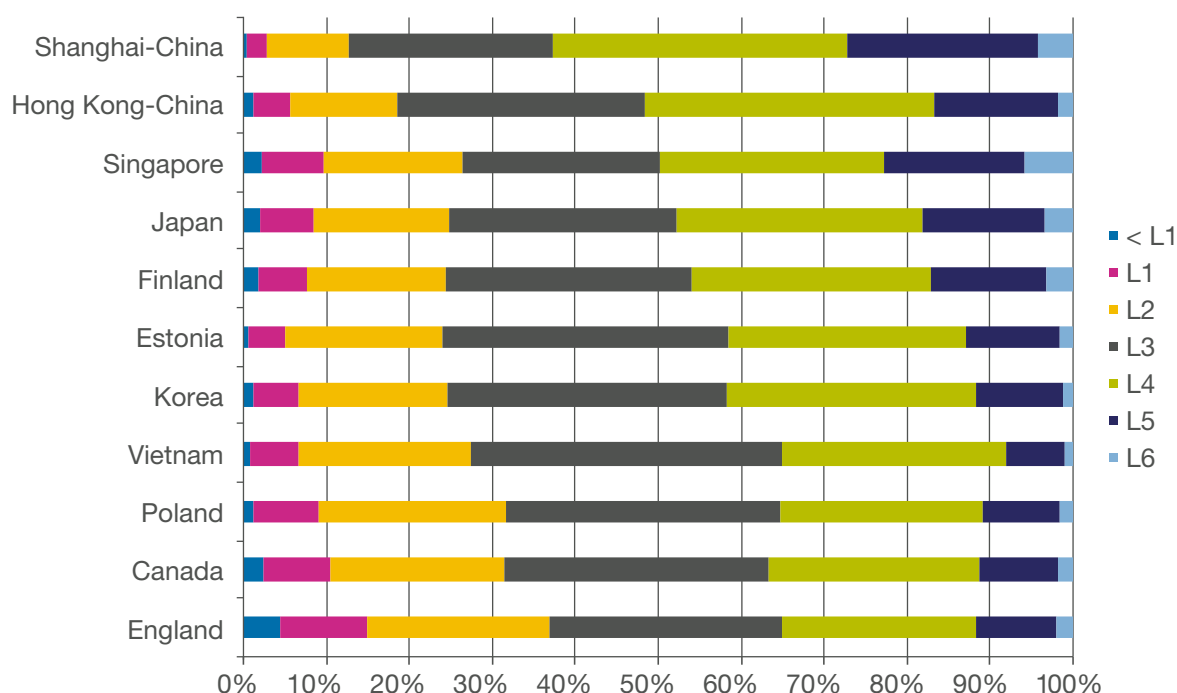
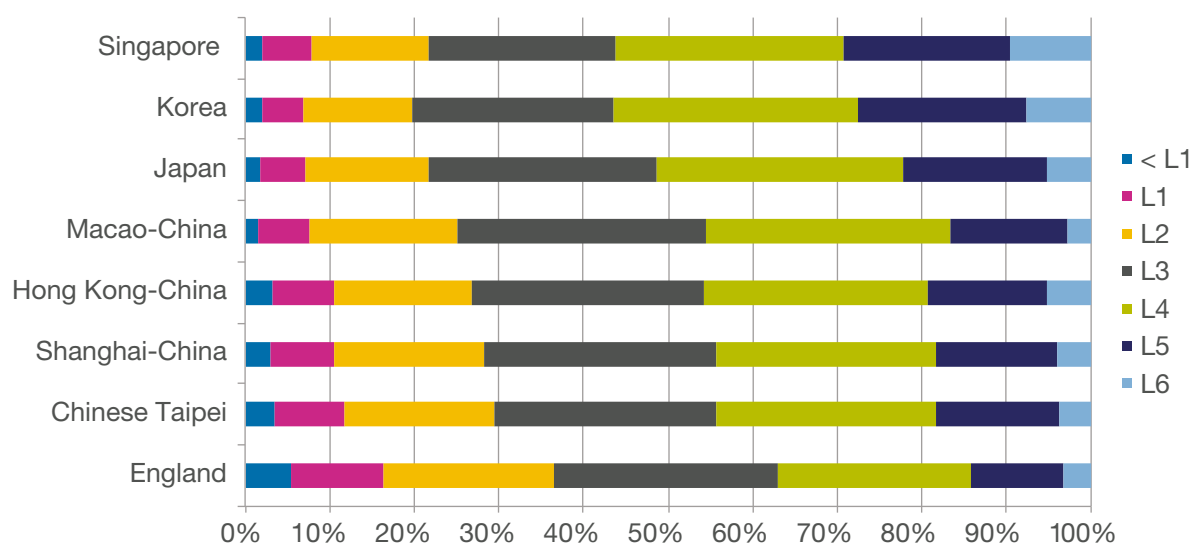


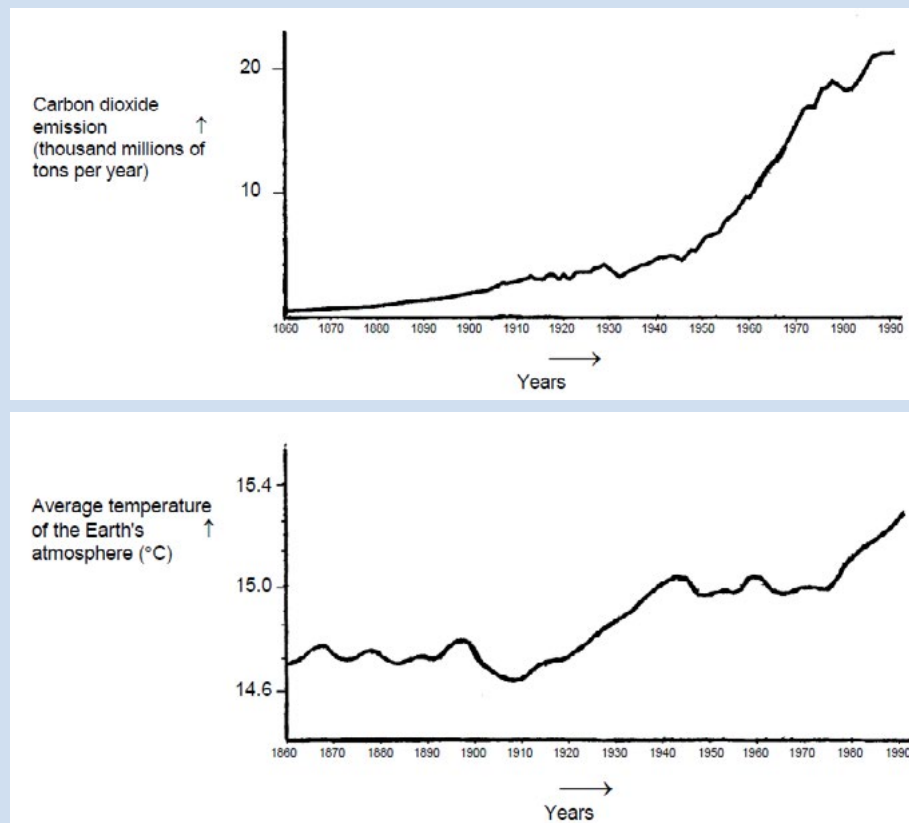
Figure 6 Percentage of pupils at each of the PISA problem-solving proficiency levels



We include below an example of a Level 5 PISA science item and a Level 5 problem-solving item, which high performers would typically be able to answer. Over ten per cent of pupils in England would typically be able to answer these questions. Whilst this is a relatively large percentage compared to many participating countries, it is a smaller percentage than some of the highest-achieving countries where, in many cases, closer to 20 per cent of pupils would be able to answer this question. In Shanghai, for example, 27 per cent of pupils would be likely to answer the science question correctly and 18 per cent of pupils would be likely to answer the problem-solving question correctly.

Example of a Level 5 science question

A student named André becomes interested in the possible relationship between the average temperature of the Earth's atmosphere and the carbon dioxide emission on the Earth. In a library he comes across the following two graphs.



André concludes from these two graphs that it is certain that the increase in the average temperature of the Earth's atmosphere is due to the increase in the carbon dioxide emission.

Question:

Another student, Jeanne, disagrees with André's conclusion. She compares the two graphs and says that some parts of the graphs do not support his conclusion. Give an example of a part of the graphs that does not support André's conclusion.

Explain your answer.

Source: OCED (2013a)

Example of a Level 5 problem-solving question

A train station has an automated ticketing machine. You use the touch screen on the right to buy a ticket. You must make three choices.

- Choose the train network you want (subway or country).
- Choose the type of fare (full or concession).
- Choose a daily ticket or a ticket for a specified number of trips. Daily tickets give you unlimited travel on the day of purchase. If you buy a ticket with a specified number of trips, you can use the trips on different days.

The BUY button appears when you have made these three choices. There is a CANCEL button that can be used at any time BEFORE you press the BUY button.

Question:

You plan to take four trips around the city on the subway today. You are a student, so you can use concession fares.

Use the ticketing machine to find the cheapest ticket and press BUY.

Once you have pressed BUY, you cannot return to the question.

Source: <http://www.oecd.org/pisa/test>

High performing all-rounders

In PISA 2012, only a very small percentage of pupils in the participating countries achieved the highest levels, Level 5 and above, in all three of the core PISA subject areas (maths, science and reading). Whilst, on average across OECD countries, 16.2 per cent of pupils are high performers in at least one of the subject areas, only 4.4 per cent of pupils managed to achieve Level 5 or above in maths, science and reading.

Of the small number of countries that have more than one in ten pupils who could be considered high performing all-rounders, all are high-achieving South East and East Asian countries.

Shanghai	19.6%
Singapore	16.4%
Japan	11.3%
Hong Kong	10.9%

These countries are managing to pursue excellence in all three subject areas and are leading the way in the competitive global economy (OECD, 2014a).

In the UK, six per cent of pupils could be considered high performing all-rounders. Therefore, teachers in England may wish to explore the policies and practices adopted in these high-achieving countries that enable them to develop so many high performing all-rounders.

2 Attitudes and behaviours associated with high performance in science and problem-solving

Exploring the pupil characteristics, behaviours and attitudes related to higher performance in science and problem-solving can help teachers and school leaders to plan teaching strategies and interventions that can help improve the performance of less able pupils.

Identifying the characteristics of high performers

Using the PISA science and problem-solving scores, information from the National Pupil Database (NPD) and the PISA Student Questionnaire we identified some of the pupil characteristics that are related to high performance. This analysis does not, however, enable us to say whether (or not) a specific pupil characteristic causes high performance.

For example, we do not know whether it is because pupils are high performers that they have particular attitudes or demonstrate particular behaviours, or whether the opposite is true. That is, they are high performers because they have particular attitudes or demonstrate particular behaviours.

A number of background characteristics are associated with the likelihood of a pupil being a high performer in the PISA science and problem-solving assessments. Pupils with the following characteristics are significantly **more likely to be high performers** in science and problem-solving:

- pupils from less disadvantaged backgrounds (as measured by the economic, social and cultural status (ESCS) index in PISA)
- pupils attending schools with lower proportions of pupils eligible for free school meals (FSM)
- pupils without special educational needs (SEN)
- boys (this was only the case in science)
- pupils of Chinese origin (this was only the case in problem-solving).

PISA index of economic, social and cultural status (ESCS)

ESCS is a measure that combines a variety of family background characteristics (OECD, 2014a). It is based on pupils' responses to questions about their parents' background and education and possessions in their homes. The measure captures different elements of social background such as economic deprivation and the value a family attributes to education and educational resources.

The findings for SEN, ethnicity and FSM mirror what is seen in the national Key Stage 4 attainment data for the same cohort⁸. That is, a higher percentage of these groups of pupils achieved five GCSEs grade A* to C compared to their less advantaged peers.

There is, however, a difference between the PISA findings and the national data in terms of gender and science attainment. The results for England for GCSE science for this cohort show that, on the whole, boys and girls perform similarly, with girls tending to slightly outperform boys⁹ rather than reflecting the PISA finding that boys are more likely to be high performers. Further analysis of the PISA data and the assessments themselves is required before we can begin to explain this difference.

⁸ The national attainment data is based on the percentage of pupils achieving the English Baccalaureate (this includes GCSE in core and additional sciences) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/280689/SFR05_2014_Text_FINAL.pdf

⁹ GCSE results for 2012 can be found here: www.jcq.org.uk



2.1 Engagement and attitudes to school

PISA allows us to explore aspects of pupil character, which, in addition to certain pupil background characteristics, are related to the likelihood of a pupil being a high performer in the PISA science and problem-solving assessments. A number of pupil attitudes and behaviours have been shown to be related to achievement. OECD in the 2013 report *Ready to Learn: Students' Engagement, Drive and Self-Beliefs* highlight, for example, that pupils need to be engaged and motivated in order to learn (OECD, 2013b). Hattie (2009) suggests that as positive attitudes towards school and subjects is linked to achievement, therefore 'by enhancing attitudes there could be reciprocal effects on achievement'. We know, from the international PISA data, that punctuality and absenteeism are linked to higher performance in maths (OECD, 2013b). We have explored whether these relationships also exist for science and problem-solving.

Pupils responded to questions in the PISA Student Questionnaire on the following topics:

- punctuality
- absenteeism
- attitudes towards school
- sense of belonging.

As expected, the responses from the **high-performing pupils, in England, suggest that their level of engagement with school and attitudes towards school are more positive than their lower performing peers**. The findings for science and problem-solving were very similar, therefore, the pupil responses reported below reflect both subjects.

- High performers were less likely to report having arrived late for school in the two weeks prior to the PISA assessment than their lower performing peers.
- The proportion of high performers in England who had not skipped whole lessons or school days in the two weeks prior to the PISA assessment is similar to the international average for all pupils.
- Less than a fifth of high performers have skipped lessons or whole school days in the two weeks prior to the assessment (compared with a quarter of lower performing pupils).
- Just under a fifth of high performers feel that school has done little to prepare them for adult life when they leave school (compared with just over a quarter of lower performing pupils).
- Only one per cent of high performers feel that school is a waste of time (compared with just over five per cent of lower performing pupils).
- High-performing pupils tend to feel slightly happier in school and are more satisfied with their school than lower performing pupils. However, for other aspects of 'belonging' (for example, *feeling like an outsider, feeling awkward and out of place and feeling lonely*), the responses of high-performing pupils were similar to or less positive than those of the lower performing pupils.

When we analysed four behavioural and attitudinal pupil characteristics in PISA (absenteeism, lateness, sense of belonging and attitudes towards school), we found that all four are significantly associated with the likelihood of being a high performer in science and problem-solving (see Table 2).

Table 2 Pupil attitudes and behaviours and likelihood of being a higher performer in science and problem-solving

Attitudes and behaviours	Science	Problem-solving
Absenteeism	-	-
Lateness	-	-
Sense of belonging	-	-
Attitudes towards school	+	+

Shaded cells: statistically significant associations

Lower levels of absenteeism and less frequent lateness are related to high science and problem-solving performance in England. This is true regardless of a pupil's background characteristics (including gender, ethnicity and socio-economic status). This finding for science and problem-solving mirrors what is seen, internationally and in England, for maths achievement. That is in the vast majority of participating countries, pupils who reported having arrived late for school and those pupils who had been absent in the last two weeks had lower scores than those who had not. This is perhaps unsurprising as we know that these pupils are missing out on learning opportunities.

On average, high performers have a more positive attitude towards school than their less able peers. These pupils are less likely to agree or strongly agree with statements such as *School is a waste of time*. In addition, in England, there is generally a more positive attitude towards schools than is seen on average internationally, with high performers having an even more positive attitude towards their school.

The relationship between sense of belonging and the likelihood of being a high performer is more complicated, perhaps even counter-intuitive. **We found that a pupil with a lower sense of belonging in school was significantly more likely to be a high performer in science and problem-solving.** It is difficult to say for certain how this relationship works. We do not know whether it is because pupils are high performers that they feel less of a sense of belonging in school or whether the opposite is true. That said, responses from high-performing pupils to the PISA Student Questionnaire suggest that they find it difficult to fit in. They are, for example, less likely to say that they make friends easily at school. This finding is mirrored to a degree in the research into the PISA results from some of the high-performing countries. In Hong Kong, Japan and Korea researchers have, for example, found that, despite high levels of attendance, pupils have a very low sense of belonging (Sui-Chu Ho, 2003). Additional research of the PISA data has also revealed that performance and engagement do not 'always go hand in hand' (Guo, 2007, p.240). Guo also found that pupils with lower levels of engagement could be found among low-, middle- and high-performing pupils.

2.2 Characteristics associated with high performance in maths and reading

We have also explored whether the pupil characteristics, behaviours and attitudes significantly associated with high performance in science and problem-solving are similarly associated with high performance in maths and reading. Given that all four PISA subject assessments are closely related we might expect to see similar relationships.

Firstly, we examined which background characteristics (for example gender, socio-economic status and ethnicity) are associated with the likelihood of a pupil being a high performer in the PISA maths and reading assessments.

Across all four subjects, pupils with a higher socio-economic status (as measured by the PISA ESCS) are more likely to be high performers. In addition, if a pupil attends a school with a higher percentage of pupils entitled to FSM he/she is less likely to be a high performer across all subjects. This mirrors the results from national attainment data, which show that a lower percentage of pupils who are eligible for FSM achieve five GCSEs grade A* to C than their peers.

The relationship between gender and the likelihood of being a high performer varies across the four subjects. In science and maths boys are significantly more likely to be high performers, whereas in reading girls are significantly more likely to be high performers than boys. However, for problem-solving there is no significant difference between girls' and boys' likelihood of being high performers. These results do not reflect those from national data where a higher percentage of girls achieve five GCSEs grade A* to C (including English and maths) and that this attainment gap actually widened in 2012/13.

When we look at ethnicity, **only in maths and problem-solving is a pupil's ethnicity related to the likelihood of them being a high performer.** In maths, Asian pupils are significantly more likely to be high performers, whereas in problem-solving, Chinese pupils are significantly more likely to be high performers. National data regarding ethnicity indicates that Chinese pupils are the highest attaining ethnic group, with a higher percentage achieving five or more GCSEs grade A* to C than pupils from other ethnic groups.

PISA also allows us to explore whether the other aspects of pupil character (behaviours and attitudes) that are related to the likelihood of a pupil being a high performer in the PISA science and problem-solving assessments are also associated with high performance in the maths and reading assessments.

When we analysed the four behavioural and attitudinal pupil characteristics in PISA, we found that not all four are significantly associated with the likelihood of being a high performer in maths and reading (see Table 3). This does not mirror what is seen for science and problem-solving.

Table 3 Pupil attitudes and behaviours and likelihood of being a higher performer in maths and reading

Attitudes and behaviours	Maths	Reading
Absenteeism	-	-
Lateness	-	-
Sense of belonging	-	-
Attitudes towards school	+	+

Shaded cells: statistically significant associations

Lower levels of absenteeism and less frequent lateness are related to high performance in maths and reading for pupils in England. The situation is similar in science and problem-solving and this is true regardless of a pupil's background characteristics (including gender, ethnicity and socio-economic status). This mirrors the international findings.

In terms of attitudes towards school, for maths, as is the case for science and problem-solving, **a more positive attitude towards school is associated with a significantly higher likelihood of being a high performer.** This relationship does not seem to exist for reading.

In addition, a sense of belonging at school is not significantly associated with the likelihood of being a high performer in maths and reading. This was not the case for science and problem-solving.

3 Summary

England's average performance in the PISA 2012 science and problem-solving assessments was significantly better than the international average. Only ten countries outperformed England in the PISA science assessment and only seven in problem-solving. In both subjects the countries that outperformed England included the high performing East and South East Asian countries. Pupils in England performed significantly better in problem-solving, on average, than pupils in countries that had a similar performance in reading mathematics and science (OECD, 2014c).

When we look at the PISA proficiency levels, for both science and problem-solving, England has a greater proportion of high achievers compared with the international average. Pupils are categorised as high performers if they achieve PISA Levels 5 and 6 (12 per cent of pupils are high performers in science and 14 per cent are high performers in problem-solving). This means that over ten per cent of pupils in England are able to answer some of the most demanding PISA science and problem-solving questions, which require them to perform complex tasks on unfamiliar topics. This compares favourably with the highest performing countries where only in the top six performing countries are a higher proportion of pupils able to answer these challenging questions. However, compared with other high achieving countries, in science, in particular, there is a greater proportion of lower achievers in England.

High performance in all four PISA subject areas is related to pupils' socio-economic background characteristics (as measured by the PISA index of ESCS) and the socio-economic composition of the school (percentage of FSM pupils) they attend.

Absenteeism and punctuality are also associated with the likelihood of being a high performer in all four of the PISA subjects. This suggests that, whilst attendance alone may not guarantee that a pupil is a high performer, more frequent opportunities to participate in lessons and become engaged in the learning processes may increase the chance of a pupil becoming a high performer.

In general, pupils in England report a relatively positive attitude towards school compared to pupils internationally. More positive attitudes towards school are also associated with a greater likelihood of being a high performer.

For science and problem-solving, pupils with a lower sense of belonging at school are more likely to be high performers. This reflects the findings from some of the other high-performing PISA countries. It may be possible to increase the sense of belonging perceived by high achievers by creating a more positive atmosphere for academic success throughout the school, where success in both academic and non-academic pursuits is celebrated.



4 What can I do in the classroom?

The evidence from PISA 2012 shows that there is a positive relationship between performance in the PISA subjects and pupil engagement. Our findings suggest that, in general, good attendance and a positive attitude towards school (key aspects of pupil engagement) are strong indicators of the likelihood of a pupil being a high performer. The OECD also found that the strategies and practices teachers use in the classroom have an important role to play in promoting engagement with school and learning (OECD, 2013b). It is therefore important to consider the pedagogical approaches that can be adopted by teachers in all subjects to increase the engagement of pupils of all abilities.

In order to establish a range of strategies and practices that may be successful in engaging pupils we have worked with independent consultants who are members of the Association for Achievement and Improvement through Assessment (AAIA), including Jenny Short, a School Professional Partner (Assessment and Leadership), Liz Thomas, a teaching and learning advisor for numeracy and Jan Evans, an independent educational consultant. We have combined the findings from some of their action research projects with those from PISA 2012, to identify a range of strategies to help you to maximise and enhance pupil involvement in their learning and provide the best possible opportunities for successful, active learning.

What strategies can I use in my practice?

Pupils may feel more engaged in school when they can see that what they are learning will be useful both immediately and in the future. To maximise pupil engagement, you could help pupils to link what they are learning to real-world situations. Pupils also tend to become more involved when they have been supported to guide their own learning than when expectations are determined solely by the teacher.

We list below a number of specific strategies that practitioners have found to enhance pupil engagement in learning. These strategies are not specifically aimed at ensuring more high achievers in PISA, instead they provide useful suggestions as to what you might do to engage learners and improve performance in your classes and schools.

Some of the suggestions below focus on specific subjects, others are more generic and could be applied across subjects.

- **Focus** on activities set in real-life contexts. In science this could mean focusing teaching on practical activities set in real-life contexts, which allow pupils to make links to everyday situations and help them to see the relevance of what they are studying.
- **Think** of the best ways to make learning relevant to your pupils. Learning becomes meaningful when pupils are able to see how what they are learning relates to their own lives. This may involve linking teaching to future careers and perhaps linking up with employers to deliver some of this content. For example, are pupils aware of the career opportunities that will be available to them if they gain a science qualification?
- **Build in** enrichment and enhancement activities at the end of a topic. This will enable pupils who are particularly keen to learn more about the topic and gain ownership of their learning.
- **Listen** to your pupils. Find out/explore what they know already and, through discussions, invite them to ask questions that might be addressed in future lessons on the topic.
- **Design tasks** that are more open ended and allow pupils to use their initiative and be creative in their learning – not tasks in which you are providing the ‘right’ answer. These tasks can provide opportunities for pupils to discuss their ideas, reflect on their learning and share their insights with their peers.
- **Make time for de-briefing sessions** to establish how your pupils’ learning has moved forward. These sessions will also give you an insight into what topics excite your pupils and what types of task inspire them to want to learn more.

What can we do as a school?

Developing pupil engagement can, and should, have a whole-school focus. As we have seen, engagement is related to performance in all of the PISA subjects. Providing opportunities for teachers to share good practice can help to ensure that pupils are engaged in all areas of the curriculum and lead to improved performance for pupils of all abilities.

- Include pupil engagement as a standing item on the agenda for whole staff and Departmental/Faculty meetings. Giving pupil engagement a prominent focus will keep it in the forefront of teachers' minds.
- Identify a range of engagement strategies based on research and staff experience. First invite staff to research and share strategies such as starter activities, or ways of closing lessons effectively. After sharing with the wider group, ask each to select one or two approaches to try out with their classes over a given period (say a month or half term), and then feedback to the group on their success, or otherwise.
- •Appoint 'learner-engagement champions'. It is often helpful to appoint two or more members of staff with responsibility for coordinating the exploration and sharing of good practice in relation to pupil engagement strategies within the school.
- Establish teacher learning communities or lesson study groups within the school. These can be within Departments/Faculties or across Departments. Later, you may wish to consider similar groups with colleagues from other schools or local authorities.
- Provide opportunities for feedback and exchange. It is important that teachers have the opportunity to reflect on and consolidate their learning. Teachers often report that their most effective continuing professional development (CPD) has emerged from professional dialogue with colleagues.
- Support teachers to take up professional development opportunities. Evidence shows that teachers with expert and up-to-date subject knowledge are better equipped to support and encourage pupils' learning.
- Consider establishing links with employers. This can be particularly important for subjects where pupils may be less engaged or where the links between learning and job opportunities are not as obvious. Research suggests that links with employers can help improve learning outcomes.

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