The National Strategies
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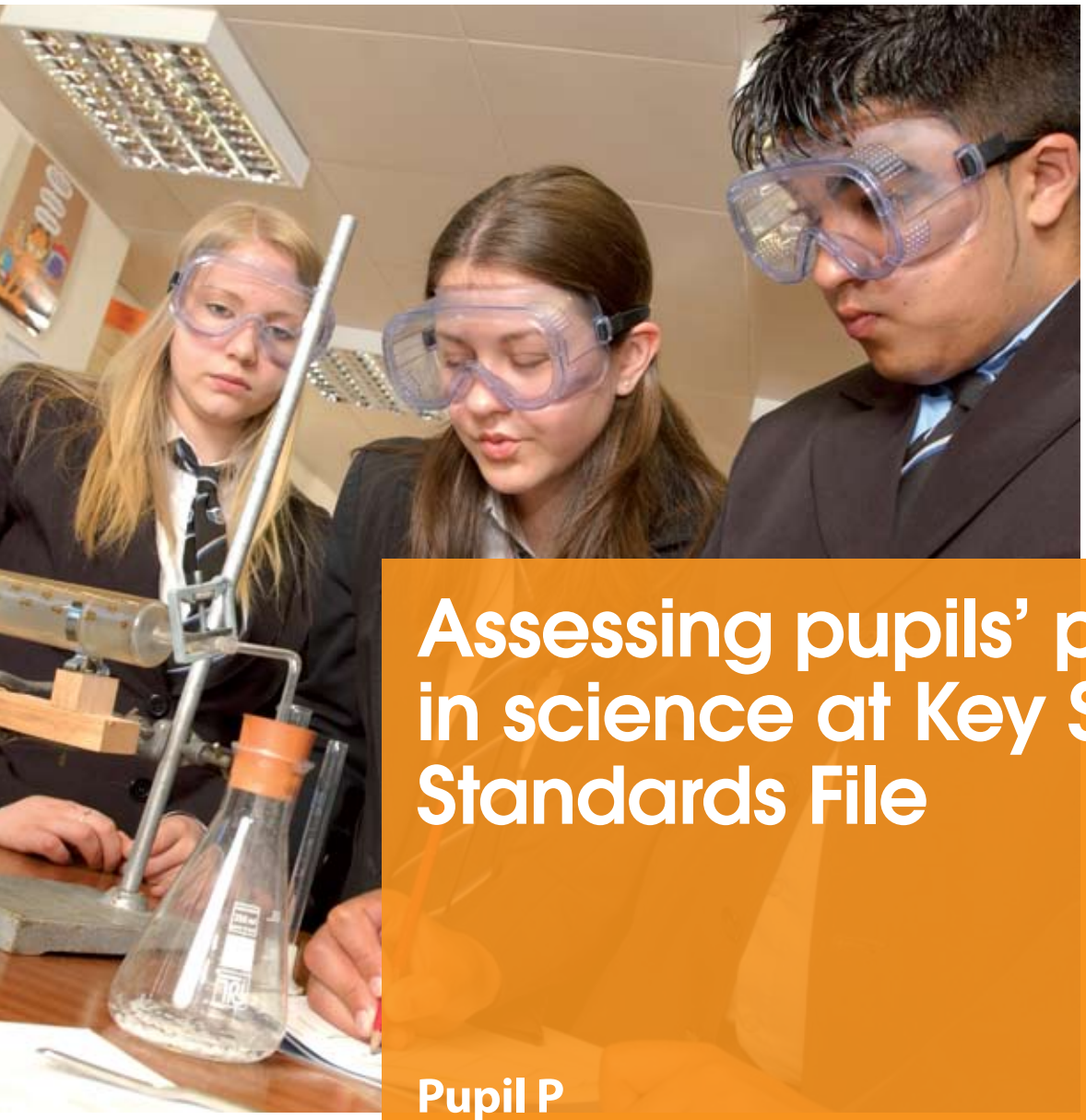

Assessing pupils' progress in science at Key Stage 3: Standards File

Pupil P

department for children, schools and families

QCA Qualifications and Curriculum Authority

Assessing pupils' progress in science at Key Stage 3: Standards File

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Pupil P Year 9 Secure level 8 Science Standards File

Pupil profile

Pupil P works in a group with levels of attainment ranging from secure level 6 upwards, and is one of the more able pupils in the group. All the pupils are used to working independently, and Pupil P's ability and confidence allow her to do so competently. Work in class is topic-based, and while there are many whole-class activities, there is also much opportunity for pupils to carry out research, using practical experiences or secondary sources, and to organise and present the outcomes in their own preferred styles.

The evidence

1. Comparing heliocentric and geocentric models of the Solar System
2. Investigating the digestion of starch
3. Introducing organic farming
4. Evaluating viewpoints on organic farming
5. Organic farming enquiry

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1. Comparing heliocentric and geocentric models of the Solar System

Assessment focuses

AF1, AF2, AF3, AF5

Context

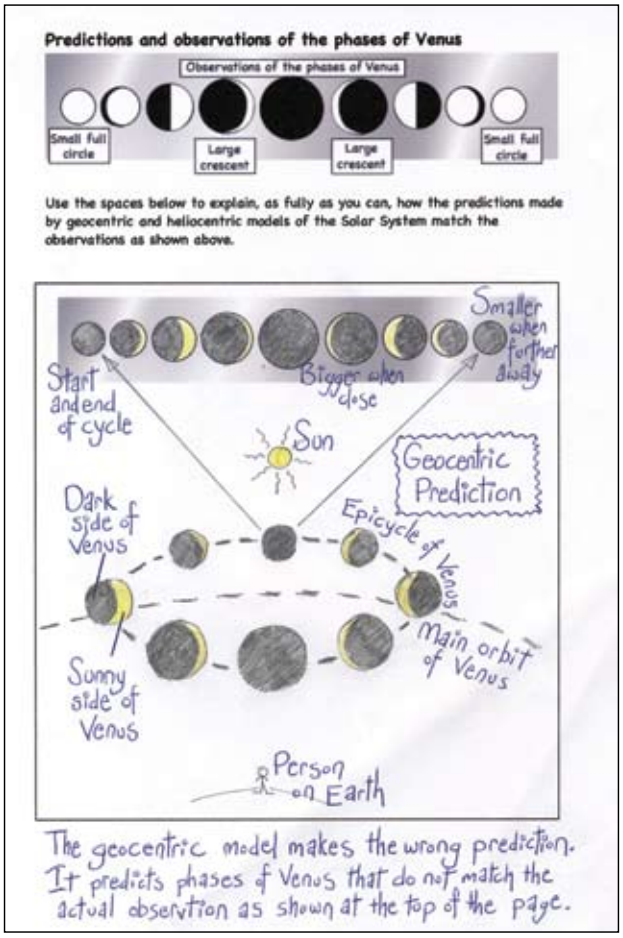
The class was working on a topic on the Solar System in order to:

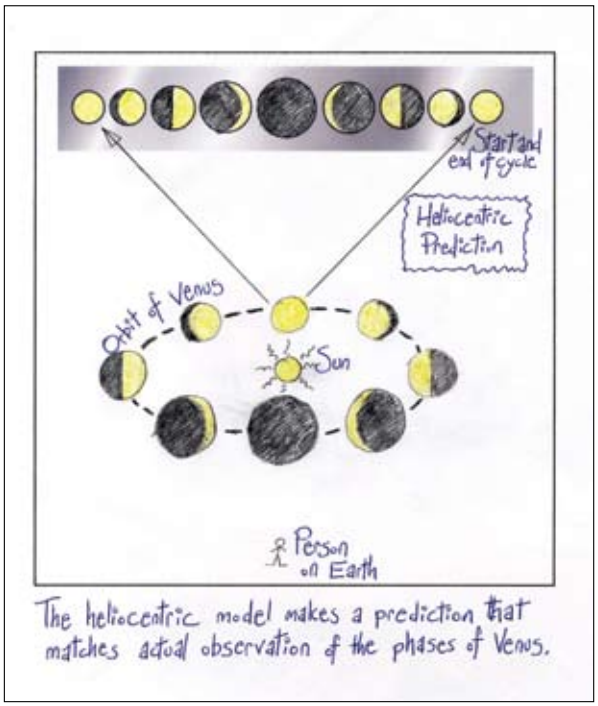
- explore the historical development in understanding of the motion of celestial bodies and the foundations of observational science developed in the seventeenth century;
- consider some examples of current scientific research.

Pupils had previously studied the phases of the Moon and explanations of the observed cycle, based on its relative movement compared with the Earth. The teacher then gave pupils a representation of the observed cycle of Venus. Pupils used a number of internet sources to find out about the predictions made by geocentric and heliocentric models.

Pupils were provided with worksheets with 'blank' cycles of Venus, and were required to shade these in and provide their own explanations, demonstrating that the geocentric model cannot account for the full cycle of Venus that includes the observed full bright, but relatively small, circle.

Pupil P's work





The heliocentric model makes a prediction that matches actual observation of the phases of Venus.

Teacher's notes

AF1

Pupil P used the worksheet to explain in detail, with correctly interpreted and presented diagrams, robust evidence that revealed a false prediction by the geocentric model and a correct prediction by the heliocentric model. Through discussion, she was able to explain how scientific theories develop although, historically, new ideas and evidence have sometimes not been recognised by the whole of society.

AF2

Through discussion, Pupil P was able to explain the significance of the telescope as an observational tool that led to the geocentric model being challenged. She was also able to describe how the views of the Roman Catholic Church influenced thinking at the time, and how theories proposed by scientists such as Galileo were deemed to be controversial, even though they were rooted in evidence.

AF3

Pupil P presented a robust and well-structured explanation, using good pictorial representations of abstract ideas to show that one model was superior to another.

AF5

She critically interpreted conflicting predictions and matched them with the observational evidence.

Next steps

- Consideration of other scientific theories such as Darwin's theory of evolution that challenged thinking at the time.

Assessment commentary

Pupil P draws '3D' representations as her explanations, showing that the two alternative views of the motions of Venus produce different predictions, and that only one of them matches the observations as shown at the start of the worksheet. The explanation is logical and detailed and illustrates a historical change in understanding that was brought about by robust evidence. Through discussions with her teacher, she is able to demonstrate a real grasp of understanding the development of scientific theories, and the issues that surround such developments.

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2. Investigating the digestion of starch

Assessment focuses

AF1, AF4, AF5

Context

The class spent eight weeks on the topic of 'food', reviewing, developing and synthesising earlier work on photosynthesis, respiration and digestion. The scheme of learning included opportunities to explore sub-topics such as global food supply and sustainable development, the British farming industry and organic farming, and healthy diets.

The work here was part of an extended practical investigation. The teacher gave different groups of students different investigations to carry out – partly because of equipment limitations and partly so that each group could then explain its work to the whole class, developing understanding of the science involved and also considering features of good investigations.

Pupil P worked in a group of three who were set the task of doing preliminary work for investigating the effect of temperature on the rate of digestion of starch by amylase, with each pupil writing reports independently.

Pupil P's work

Starch and amylase – first experiment

Starch is a carbohydrate, made by plants from the glucose that they produce by photosynthesis. Its molecules have long chains of glucose so that they act as glucose stores. A lot of food for humans and other animals is made of a lot of starch. Wheat, potato and rice, for example, have a lot of starch.

Starch is important to us as well as to plants. Just like the plants do, we can break it back down into glucose so that our bodies can then be supplied with energy by the process of respiration (a chemical reaction with oxygen). Since some starch is not soluble in water we have to break it down before it can pass into our blood. Other starch is soluble but it is still much easier for small glucose molecules to pass in to the blood and into cells. That means that we have to digest it.

Saliva contains a substance called amylase. It is an enzyme which means that it is a catalyst in the body. It breaks up the long molecules of starch into much smaller molecules of glucose. Glucose is soluble and easy to move around the body in blood and to pass into cells.

Digestion of starch begins in our mouths. Teeth help the process by breaking up the food to increase the surface and chewing helps the saliva and the amylase to mix with the starch.

Our first experiment

We wanted to see how quickly the amylase would work. (We then wanted to see how the rate of change was affected by temperature, but that was our second experiment.)

We used a light sensor and a datalogging program to collect data and plot a graph.

Trial run

First we carried out a trial, using just a stopwatch and our eyes. We were given some starch solution (with 0.2% of soluble starch) and poured 20 ml into two identical test tubes. We added enough drops of iodine solution, the same number to each test tube, to make the solutions go very dark blue. We were also given some amylase solution. We added some of this to ONE of the test tubes. It started to become less dark,. We made judgements, just with our eyes, of the brightness of the light that could pass through the solutions.

These are our trial results:

Time (seconds)	0	5	10	15	20	25	30	35	40	45
Light intensity judged by human eyes (percentage of full brightness)	5	10	20	25	35	40	50	60	65	70

The solution became steadily less dark. After 45 seconds the light intensity we could see was still increases, and it kept on increasing for a few minutes (about 5 minutes) before it stopped changing so quickly. That told us that we needed to make measurements over several minutes, so we decided to measure for ten minutes. Also, it was very hard to judge the changes in light intensity with our eyes. When we thought it was 70% of maximum that was only a rough comparison, so that told us that we had to use a light sensor and a computer. There was no point in plotting a graph from this 'estimation' data since the trial had told us what we wanted to know.

Method

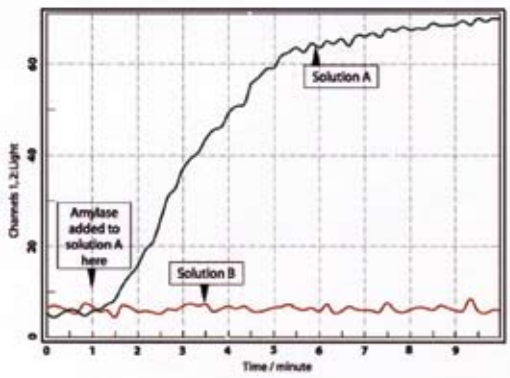
We clamped a light sensing probe beneath the test tube and connected the probe to the computer. We clamped a bright white LED above the test tube so that it would shine towards the probe.

We added 20 ml of starch, iodine and water (SOLUTION B) to the test tube and began to take measurements, which we did for 10 minutes. Then we took a clean test tube and added 20 ml of starch, iodine and water (SOLUTION A) to that. We began to take measurements as before, but after 1 minute we added some amylase.

We used the computer software to plot the two graphs, on the same axes.

Results

Time (seconds)	SOLUTION B Starch, iodine + water, light reading	SOLUTION A Starch, iodine + water PLUS amylase, light reading
0	6.1	48
10	6.5	40
20	6.0	51
30	5.2	57
40	4.9	52
50	7.0	42
60	6.3	53
70	5.1	57
80	5.5	69
90	3.9	74
100	6.4	110
110	6.0	139
120	5.1	160
130	5.3	194
140	5.0	209
150	4.8	259
160	5.8	316
170	5.6	327
180	6.2	369
190	6.8	392
200	6.2	405
210	6.6	433
220	5.1	460
230	5.8	469
240	6.1	495
250	5.8	508
260	6.2	511
270	5.2	561
280	5.1	574
290	5.5	590
300	6.0	593
310	6.2	619
320	6.5	626
330	5.8	637
340	5.5	629
350	6.0	644
360	5.0	638
370	6.6	649
380	5.1	645
390	5.3	654
400	6.2	639
410	5.5	662
420	5.2	661
430	5.2	667
440	5.0	660
450	6.7	676
460	5.7	673
470	5.0	681
480	5.8	676
490	6.0	679
500	5.9	677
510	5.3	688
520	6.3	683
530	5.7	684
540	5.2	685
550	5.0	691
560	7.5	684
570	5.1	699
580	4.8	693
590	5.3	698
600	5.1	698



Conclusion

With solution B, the light intensity detected by the probe stayed more or less the same for the ten minutes.

With solution A the light intensity starts to increase once the amylase was added. More light passed through the solution as the amylase acts as an enzyme and breaks down the starch into glucose.

The amylase starts to break down starch quite quickly. That means that when we eat starch some glucose can be made available for our blood quite quickly – some within a minute and much more over the next 5 minutes.

Evaluation and information for our second experiment

Using a computer to record our data gave us a more reliable set of results. It was faster than human eyes, more reliable and able to keep taking measurements for a long period of time.

We are planning to do a second experiment to see what happens when the solution with amylase has different temperatures. That will be a 'rate of reaction' investigation. We now know that we should use the probe to measure light intensity, we should make measurements for ten minutes. We will use test tubes that are identical with identical amounts of solution. We will need a way to measure the rate of reaction. We will use the computer to plot graphs for each temperature, and we will make measurements from the graphs. We will measure the time for the light intensity to become 60% of maximum after adding the amylase.

Teacher's notes

AF1

Pupil P brought ideas together from different areas of science, explaining the nature of starch including its relationship to glucose, by referring to chemical structure (in non-technical but correct terms), photosynthesis, respiration and digestion.

AF4

This first experiment was itself, effectively, a trial run for later work on the effect of temperature, but the pupils carried out an initial trial in order to obtain information on the timescale of change. They used this to justify the general strategy, recognising the need to use a data logger to obtain precise and reliable data.

AF5

The pupils did not know in advance what their graph would look like, and Pupil P has, in her report, interpreted the data correctly and has related the findings to its scientific basis, referring to the rate of digestion of starch by amylase and its relevance to the availability of glucose to the body.

The investigation allowed the group to make coherent plans to take their investigations further and to explore the effect of temperature.

Next steps

- Completion of the second experiment, reaching a conclusion on the effect of temperature.
- Presentation to the rest of the class, sharing an outline of their investigation and their conclusions, and relating their findings to scientific knowledge and understanding.

Assessment commentary

Pupil P's collaborative investigation shows a confidence in breaking down an overall process into stages, first performing a trial run and then a data-gathering process that is preparation for a further planned investigation. The report links the investigation to the science in a synoptic manner, drawing on a relevant conceptual background from various areas of science.

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3. Introducing organic farming

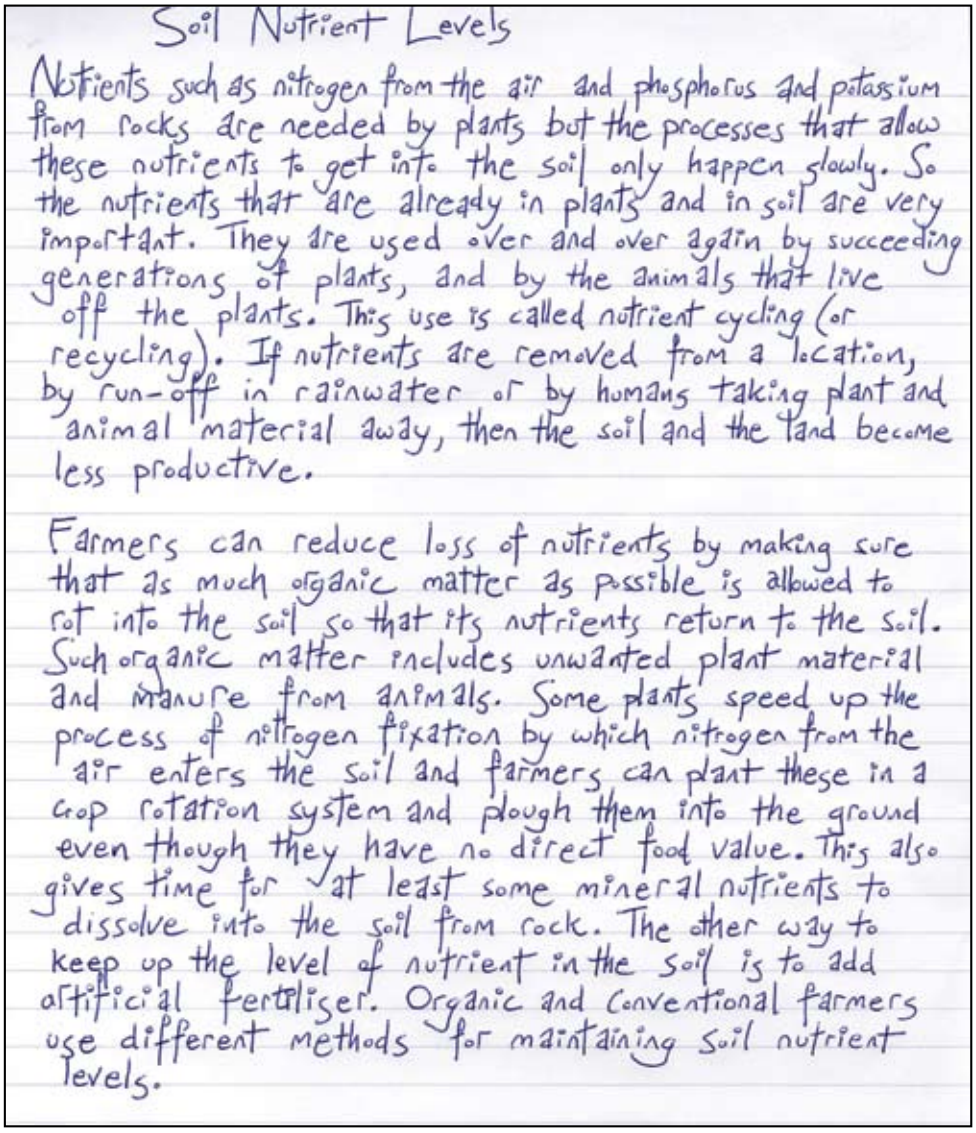
Assessment focuses

AF1, AF3

Context

The teacher asked pupils to produce introductions to organic farming, using their prior knowledge and drawing on any necessary extra research. The purpose of their introductions was to provide a scientific background to the basic principles, without going as far as explaining detailed distinctions between organic and conventional farming. They were advised to use just two sides of paper and to use graphics as well as text.

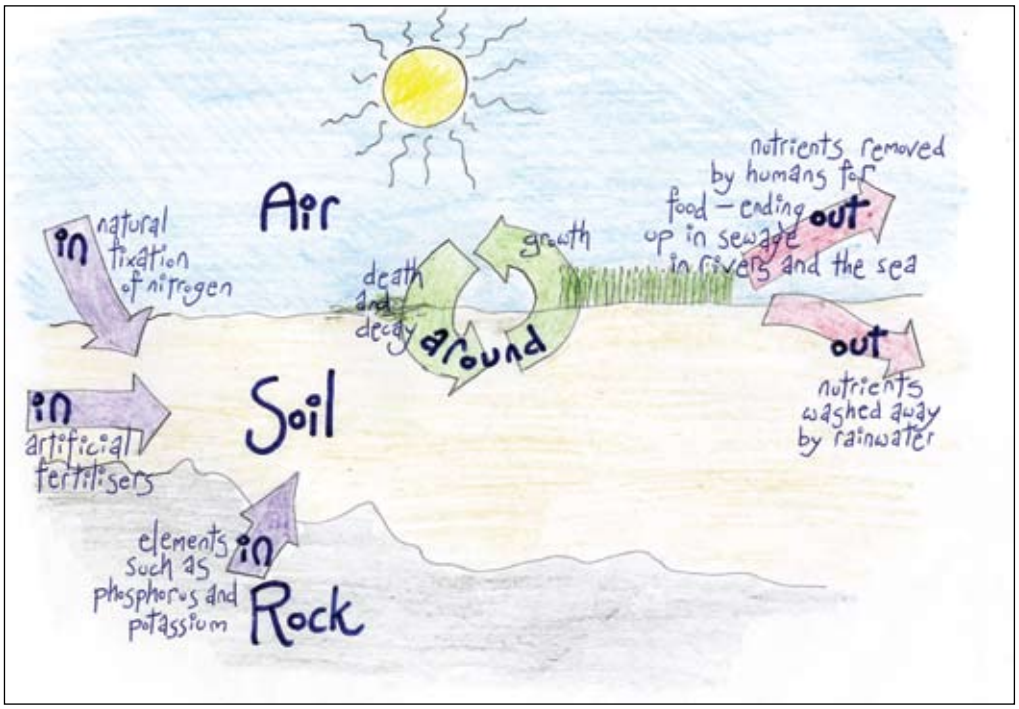
Pupil P's work



Soil Nutrient Levels

Nutrients such as nitrogen from the air and phosphorus and potassium from rocks are needed by plants but the processes that allow these nutrients to get into the soil only happen slowly. So the nutrients that are already in plants and in soil are very important. They are used over and over again by succeeding generations of plants, and by the animals that live off the plants. This use is called nutrient cycling (or recycling). If nutrients are removed from a location, by run-off in rainwater or by humans taking plant and animal material away, then the soil and the land become less productive.

Farmers can reduce loss of nutrients by making sure that as much organic matter as possible is allowed to rot into the soil so that its nutrients return to the soil. Such organic matter includes unwanted plant material and manure from animals. Some plants speed up the process of nitrogen fixation by which nitrogen from the air enters the soil and farmers can plant these in a crop rotation system and plough them into the ground even though they have no direct food value. This also gives time for at least some mineral nutrients to dissolve into the soil from rock. The other way to keep up the level of nutrient in the soil is to add artificial fertiliser. Organic and Conventional farmers use different methods for maintaining soil nutrient levels.



Teacher's notes

AF1

Pupil P explained the key points, which she refined from a wide range of available information, in text and in graphics. In doing so, she made some decisions about the relative importance of a large number of factors.

AF3

In order to produce the work, Pupil P had to refer to several information sources and make judgements on their value to her task, being aware of their limitations.

Next steps

- Exploration of the use and misuse of the term 'sustainability'.

Assessment commentary

Pupil P has synthesised information to produce a concise introduction that mentions the key points of nutrient flow. The diagram used is particularly clear and concise, and a good example of the creative representation of information.

4. Evaluating viewpoints on organic farming

Assessment focuses

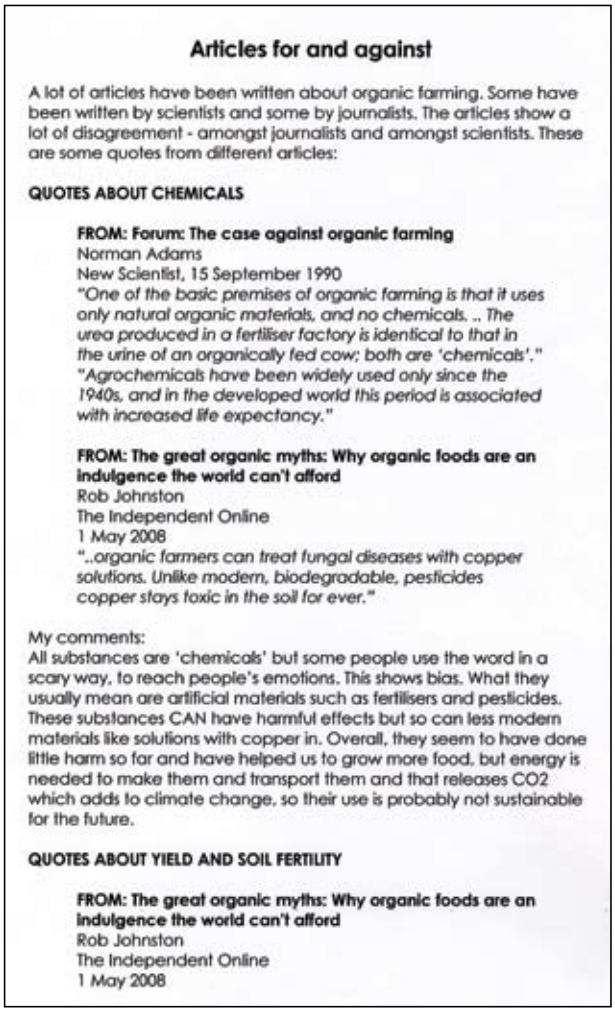
AF1, AF2, AF3

Context

Pupils had used materials from the Learning Skills for Science project to consider the use of text resources, including print and internet materials.[1] This included some introductory work on assessing the match of resources to particular needs, assessing the reliability of the resource and looking for bias.

The teacher asked the pupils to gather quotes about organic farming from articles found on the internet, to look for bias, and to produce a report with comments.

Pupil P's work



Articles for and against

A lot of articles have been written about organic farming. Some have been written by scientists and some by journalists. The articles show a lot of disagreement - amongst journalists and amongst scientists. These are some quotes from different articles:

QUOTES ABOUT CHEMICALS

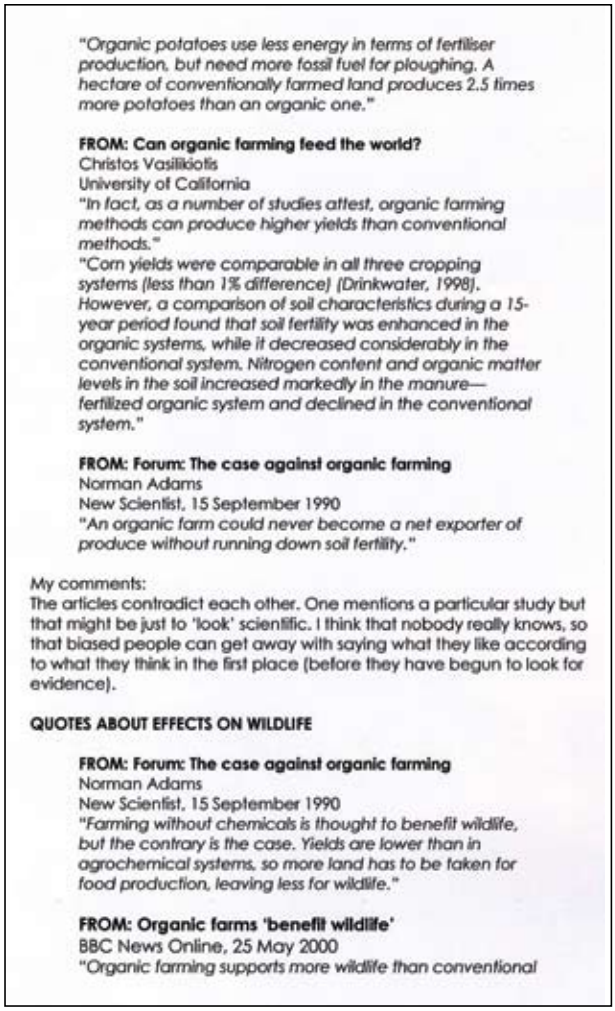
FROM: Forum: The case against organic farming
Norman Adams
New Scientist, 15 September 1990
"One of the basic premises of organic farming is that it uses only natural organic materials, and no chemicals. .. The urea produced in a fertiliser factory is identical to that in the urine of an organically fed cow; both are 'chemicals'."
"Agrochemicals have been widely used only since the 1940s, and in the developed world this period is associated with increased life expectancy."

FROM: The great organic myths: Why organic foods are an indulgence the world can't afford
Rob Johnston
The Independent Online
1 May 2008
"..organic farmers can treat fungal diseases with copper solutions. Unlike modern, biodegradable, pesticides copper stays toxic in the soil for ever."

My comments:
All substances are 'chemicals' but some people use the word in a scary way, to reach people's emotions. This shows bias. What they usually mean are artificial materials such as fertilisers and pesticides. These substances CAN have harmful effects but so can less modern materials like solutions with copper in. Overall, they seem to have done little harm so far and have helped us to grow more food, but energy is needed to make them and transport them and that releases CO2 which adds to climate change, so their use is probably not sustainable for the future.

QUOTES ABOUT YIELD AND SOIL FERTILITY

FROM: The great organic myths: Why organic foods are an indulgence the world can't afford
Rob Johnston
The Independent Online
1 May 2008



"Organic potatoes use less energy in terms of fertiliser production, but need more fossil fuel for ploughing. A hectare of conventionally farmed land produces 2.5 times more potatoes than an organic one."

FROM: Can organic farming feed the world?
Christos Vasilikiotis
University of California
"In fact, as a number of studies attest, organic farming methods can produce higher yields than conventional methods."
"Corn yields were comparable in all three cropping systems (less than 1% difference) (Drinkwater, 1998). However, a comparison of soil characteristics during a 15-year period found that soil fertility was enhanced in the organic systems, while it decreased considerably in the conventional system. Nitrogen content and organic matter levels in the soil increased markedly in the manure—fertilized organic system and declined in the conventional system."

FROM: Forum: The case against organic farming
Norman Adams
New Scientist, 15 September 1990
"An organic farm could never become a net exporter of produce without running down soil fertility."

My comments:
The articles contradict each other. One mentions a particular study but that might be just to 'look' scientific. I think that nobody really knows, so that biased people can get away with saying what they like according to what they think in the first place (before they have begun to look for evidence).

QUOTES ABOUT EFFECTS ON WILDLIFE

FROM: Forum: The case against organic farming
Norman Adams
New Scientist, 15 September 1990
"Farming without chemicals is thought to benefit wildlife, but the contrary is the case. Yields are lower than in agrochemical systems, so more land has to be taken for food production, leaving less for wildlife."

FROM: Organic farms 'benefit wildlife'
BBC News Online, 25 May 2000
"Organic farming supports more wildlife than conventional

1 Learning Skills for Science Project © Gatsby Science Enhancement Programme. http//www.sep.org.uk/lss.

methods with greater numbers of birds, plants and other species, a report claims.
A lengthy series of studies has found that chemical-free farming systems support substantially higher levels of wildlife than equivalent conventionally managed farms. The Soil Association claims the research provides the first comprehensive evidence that wildlife benefits from "non-industrial" farming methods."

My comments:
There is contradiction again! The environment is very complicated and maybe scientific investigations can disagree with each other, depending on the details. People can choose to ignore some scientific investigations and just lookat the ones that support their views. People who want to persuade can say what they like!

QUOTES ABOUT OTHER ENVIRONMENTAL EFFECTS

FROM: Can organic farming feed the world
Christos Vasilikiotis
University of California
"Moreover, the conventional system had the highest environmental impact, where 60% more nitrate was leached into the groundwater over a 5 year period than in the organic systems (Drinkwater, 1998)."

FROM: The great organic myths: Why organic foods are an indulgence the world can't afford
Rob Johnston
The Independent Online
1 May 2008
".. organically reared cows burp twice as much methane as conventionally reared cattle – and methane is 20 times more powerful a greenhouse gas than CO2."

My comments:
Nitrates in the ground can be harmful if they get into water supplies, but so far there is little serious harm in the world from this compared with the benefit of growing food. Whether or not the methane burped by cows makes much difference depends on the total amount – 20 times more than very little is still not very much. This person shows that he is biased by not explaining this more carefully.

QUOTES ABOUT HUMAN NUTRITION

FROM: Official: organic really is better
Jon Ungoed-Thomas

The Sunday Times, 28 October 2007
"The biggest study into organic food has found that it is more nutritious than ordinary produce and may help to lengthen people's lives. .. The study found that organic fruit and vegetables contained as much as 40% more antioxidants, which scientists believe can cut the risk of cancer and heart disease, Britain's biggest killers. They also had higher levels of beneficial minerals such as iron and zinc."

FROM: Organic foods
Carl K Winter
Food Technology, journal of the Institute of Food Technologists
October 2006
"While many studies demonstrate qualitative differences between organic and conventional foods with respect to pesticide residues and nutrients, it is premature to conclude that either food system is superior to the other. Pesticide residues, naturally occurring toxins, nitrites, and polyphenolic compounds benefits on a dose-related basis, and data currently do not exist to ascertain whether the differences in the levels of such chemicals between organic foods and conventional foods are of health significance."

My comments
The second article is more honest. It says that there is not enough data to make a decision on whether organic food is better than conventional food.

Overall comment
With all of this disagreement it is very hard to know what is best, organic or conventional farming. Many of the articles are biased. They are written by people who have already made their minds up, regardless of the evidence. They won't admit that there is not enough evidence, and they want to persuade everybody else that they are right.

Teacher's notes

AF1

Pupil P recognises that the emergence of new ideas and evidence leads to changes in scientific theories, but that there is not necessarily enough evidence for the possible advantages or disadvantages of organic farming to be classified as scientific knowledge. She picks up on some subtle arguments, going some way towards evaluating the relative importance of several factors in the debate.

AF2

Pupil P's final comment provides a balanced judgement, that evidence is insufficient, following an evaluation of some of the implications of organic and conventional farming methods. She touched upon unintended consequences, such as in recognising the impact on wildlife, and wider environmental issues such as carbon dioxide and methane emissions, and nitrates in water. She examined some of the effects of the two alternative farming methods on society as a whole, including at a global level relating to food supply and climate change.

AF3

Pupil P looked at a wide selection of resources and gathered quotes from them. She critically evaluated the information sources and identified possible areas of misinterpretation and imbalance. She suggested a major limitation in that the writers were making assertions based on inadequate evidence.

Next steps

- Exploring views of local farmers.
- Class debate on organic versus conventional farming methods.

Assessment commentary

The outline activity provided by the teacher provides an opportunity for the Pupil P to explore and respond, and she makes the most of this. She takes a very thoughtful approach to the relationship between evidence-based knowledge and opinion, to the difficulty of reaching conclusions in a complex matter, and to decision-making processes relating to an issue of society-wide importance.

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5. Organic farming enquiry

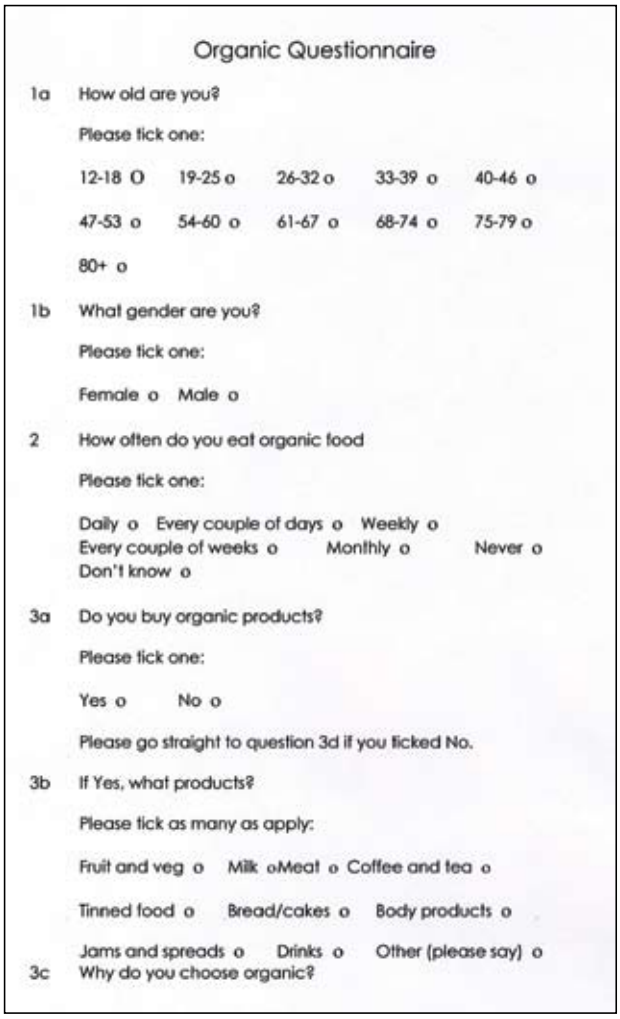
Assessment focuses

AF4, AF5

Context

As part of the sequence of activity on organic and conventional farming methods, the teacher asked pupils to carry out an active enquiry, working individually and choosing their own subject and approach, including a safety assessment that the teacher would check. Some pupils carried out practical investigations such as soil analyses, but Pupil P devised and used a questionnaire to find out about the use and perception of organic products, presenting her results graphically and providing some summary findings.

Pupil P's work



Organic Questionnaire

1a How old are you?

Please tick one:

12-18 O 19-25 o 26-32 o 33-39 o 40-46 o

47-53 o 54-60 o 61-67 o 68-74 o 75-79 o

80+ o

1b What gender are you?

Please tick one:

Female o Male o

2 How often do you eat organic food

Please tick one:

Daily o Every couple of days o Weekly o
Every couple of weeks o Monthly o Never o
Don't know o

3a Do you buy organic products?

Please tick one:

Yes o No o

Please go straight to question 3d if you ticked No.

3b If Yes, what products?

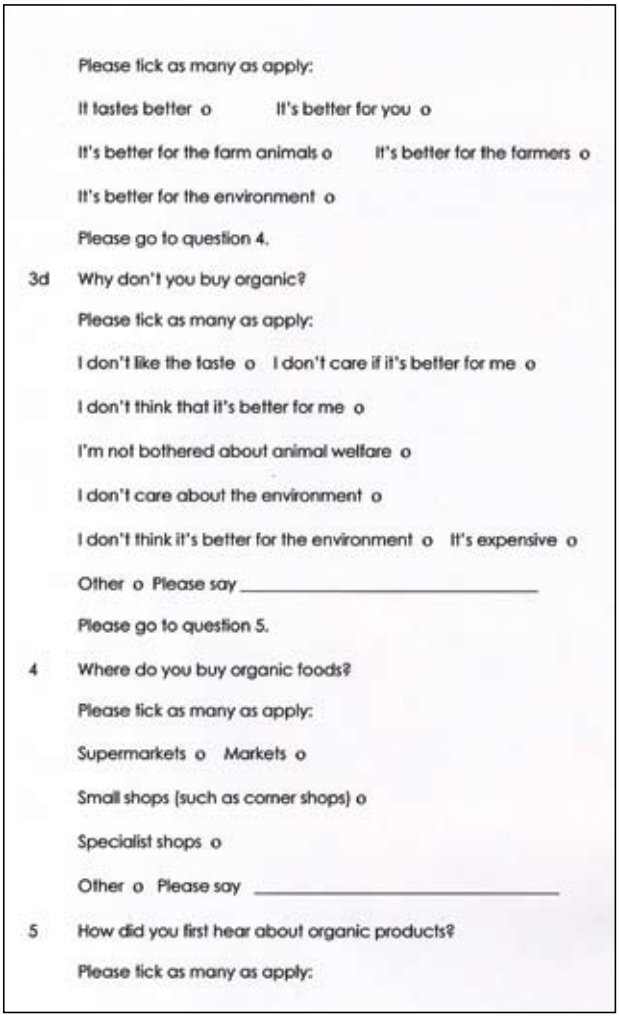
Please tick as many as apply:

Fruit and veg o Milk oMeat o Coffee and tea o

Tinned food o Bread/cakes o Body products o

Jams and spreads o Drinks o Other (please say) o

3c Why do you choose organic?



Please tick as many as apply:

It tastes better o It's better for you o

It's better for the farm animals o It's better for the farmers o

It's better for the environment o

Please go to question 4.

3d Why don't you buy organic?

Please tick as many as apply:

I don't like the taste o I don't care if it's better for me o

I don't think that it's better for me o

I'm not bothered about animal welfare o

I don't care about the environment o

I don't think it's better for the environment o It's expensive o

Other o Please say _____

Please go to question 5.

4 Where do you buy organic foods?

Please tick as many as apply:

Supermarkets o Markets o

Small shops (such as corner shops) o

Specialist shops o

Other o Please say _____

5 How did you first hear about organic products?

Please tick as many as apply:

I saw it in shops o I read about it in a newspaper / magazine o

I heared about it on TV or radio o Someone told me about it o

Other o Please say _____

6a What do you think of the price of organic produce?

Please tick one:

It's fair and a good price pay o It's too expensive o

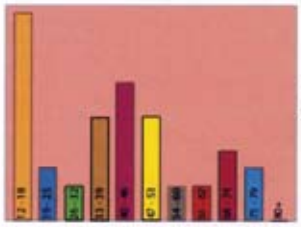
6b Would you pay more for organic foods?

Please tick one:

Yes o No o It depends what it is o

Thank you for completing the questionnaire!

Questionnaire results presentation, page 1



1a Ages of the questionnaire sample

1b Genders of the questionnaire sample

2 How often do you eat organic food?

3a Do you buy organic products?

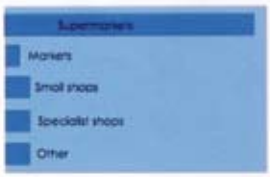
1 Fruit and veg
2 Meat
3 Milk
4 Coffee and tea

3b What products?

3c Why do you choose organics?

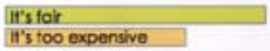
Questionnaire results presentation, page 2

3d Why don't you buy organic?



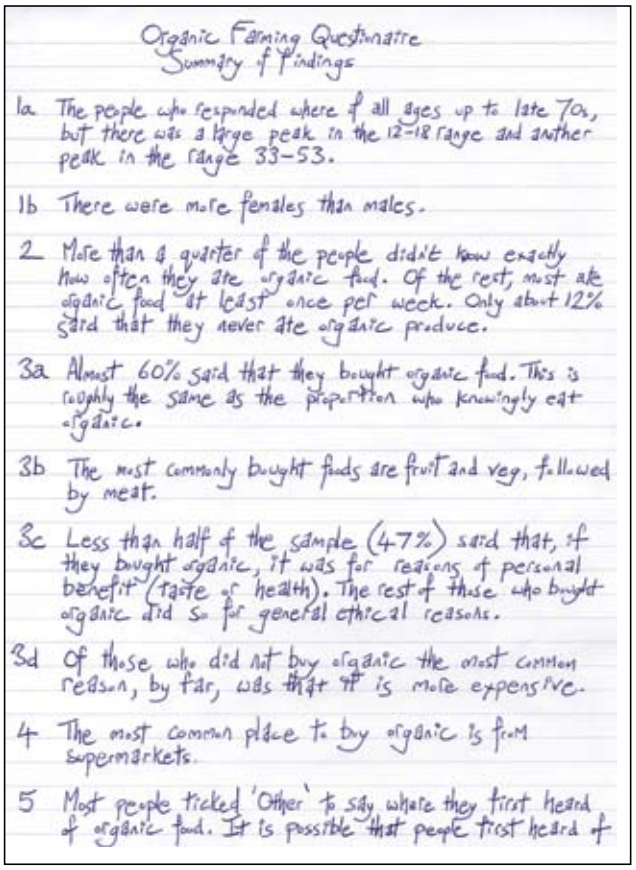
4 Where do you buy organic foods?

5 How did you first hear about organic products?



6 What do you think of the price of organic produce?

7 Would you pay more for organic foods?



Organic Farming Questionnaire
Summary of findings

1a The people who responded where of all ages up to late 70s, but there was a large peak in the 12–18 range and another peak in the range 33–53.

1b There were more females than males.

2 More than a quarter of the people didn't know exactly how often they ate organic food. Of the rest, most ate organic food at least once per week. Only about 12% said that they never ate organic produce.

3a Almost 60% said that they bought organic food. This is roughly the same as the proportion who knowingly eat organic.

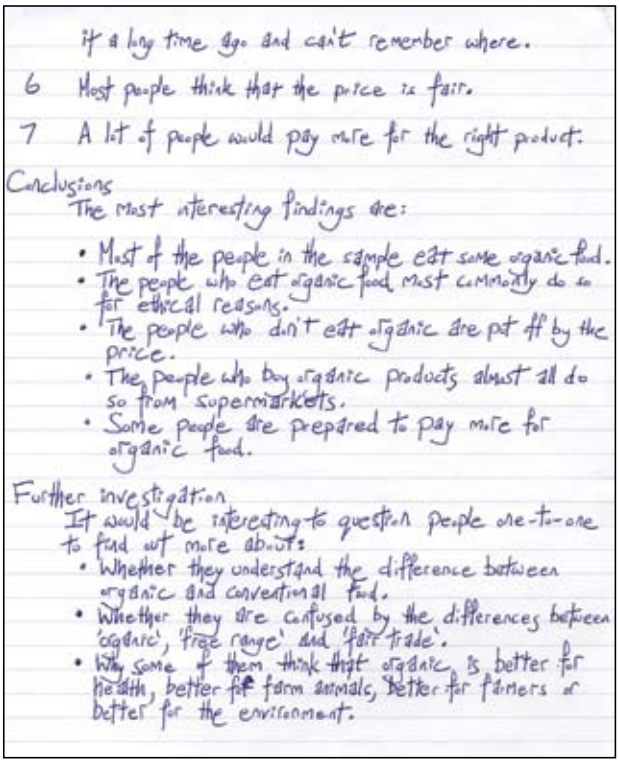
3b The most commonly bought foods are fruit and veg, followed by meat.

3c Less than half of the sample (47%) said that, if they bought organic, it was for reasons of personal benefit (taste or health). The rest of those who bought organic did so for general ethical reasons.

3d Of those who did not buy organic the most common reason, by far, was that it is more expensive.

4 The most common place to buy organic is from supermarkets.

5 Most people ticked 'Other' to say where they first heard of organic food. It is possible that people first heard of



it a long time ago and can't remember where.

6 Most people think that the price is fair.

7 A lot of people would pay more for the right product.

Conclusions
The most interesting findings are:

- Most of the people in the sample eat some organic food.
- The people who eat organic food most commonly do so for ethical reasons.
- The people who don't eat organic are put off by the price.
- The people who buy organic products almost all do so from supermarkets.
- Some people are prepared to pay more for organic food.

Further investigation
It would be interesting to question people one-to-one to find out more about:

- Whether they understand the difference between organic and conventional food.
- Whether they are confused by the differences between 'organic', 'free range' and 'fair trade'.
- Why some of them think that organic is better for health, better for farm animals, better for farmers or better for the environment.

Teacher's notes

AF4

Pupil P developed her own strategy to investigate the level of use and purchase of organic products, and chose a data collection process that was able to produce useful data, consulting with the teacher on safety issues and limiting her survey to known people.

AF5

She proposed explanations for several of her survey findings, making allowances for uncertainties as appropriate. She processed data to generate scale representations, and made suggestions for possible extension of her study.

Next steps

- Presentation to the rest of the class, using agreed criteria for peer assessment.

Assessment commentary

The questionnaire limits itself to simple answers, and Pupil P acknowledges in her conclusions that further questions could be constructed. The limited scope is not necessarily indicative of limitations in Pupil P's progress, since it shows a realistic approach. The work shows high standards of information selection; synthesis and communication development; adaptation and performance of safe data-collection; and thoughtful analysis of a fairly complex set of data.

Assessment summary

AF1 Thinking scientifically

Pupil P can explain processes and phenomena logically and in detail, evaluating multiple factors and bringing ideas together from different areas of science. This collection of evidence shows her assessing evidence that has changed established understanding. Her work here for AF1 is at secure level 8.

AF2 Understanding the applications and implications of science

Issues of organic and conventional farming and of the heliocentric revolution provide opportunities for Pupil P to show a high level of understanding of the applications and implications of science and associated technology, and in particular the interactions of scientific and technological change with broader society. She takes the opportunity both in a historical context (the heliocentric revolution) and in a contemporary context (organic and conventional farming), showing work at secure level 8 for AF2.

AF3 Communicating and collaborating in science

One of the items of evidence in this collection is based on a practical activity carried out collaboratively, but the work provides little opportunity for Pupil P to show an understanding of collaboration in science in general and the specialisms and skills that are required within such collaborative work. However, she is able to show her ability in taking a critical approach to sources of information and in particular to look for bias through misrepresentation or lack of balance. She also clearly displays her skills in the selection, synthesis and presentation of information in her own original and thoughtful ways. The work here shows progress to secure level 8.

AF4 Using investigative approaches

Pupil P's investigations here involve her collaborative practical investigation and her individual questionnaire survey. In both cases she is involved in making and justifying the approach taken. This indicates work at secure level 8 for AF4.

AF5 Working critically with evidence

Pupil P shows that she can process complex data, and critically interpret, evaluate and synthesise conflicting evidence. She matches findings with scientific explanations and uses these to plan future work. Her progress for AF5 is at secure level 8.

Overall assessment judgement

Pupil P is independently thoughtful. She can work on complex issues, recognising the complexity and the subtleties of explanations and arguments. She can spot attempts to cut corners with the truth. Pupil P recognises the place of science in society, communicates clearly in her own style, uses secondary sources with due caution, gathers data systematically and analyses it to develop conclusions that she can then apply.

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APP science assessment guidelines: levels 7 and 8

Name…P……

	AF1 – Thinking scientifically	AF2 – Understanding the applications and implications of science	AF3 – Communicating and collaborating in science	AF4 – Using investigative approaches	AF5 – Working critically with evidence
Level 8	**Across a range of contexts and practical situations pupils:** ● Describe or explain processes or phenomena, logically and in detail, making use of abstract ideas and models from different areas of science ● Select and justify an appropriate approach to evaluating the relative importance of a number of different factors in explanations or arguments ● Analyse the development of scientific theories through the emergence of new, accepted ideas and evidence ☑	**Across a range of contexts and practical situations pupils:** ● Describe ways in which the values of a society influence the nature of the science developed in that society or period of history ● Evaluate the effects of scientific or technological developments on society as a whole ● Explain the unintended consequences that may arise from scientific and technological developments ● Make balanced judgements about particular scientific or technological developments by evaluating the economic, ethical/moral, social or cultural implications ☑	**Across a range of contexts and practical situations pupils:** ● Critically evaluate information and evidence from various sources, explaining limitations, misrepresentation or lack of balance ● Present robust and well structured explanations, arguments or counter arguments in a variety of ways ● Suggest the specialisms and skills that would be needed to solve particular scientific problems or to generate particular new scientific or technological developments ☑	**Across a range of contexts and practical situations pupils:** ● Justify their choice of strategies for investigating different kinds of scientific questions, using scientific knowledge and understanding ● Choose and justify data collection methods that minimise error, and produce precise and reliable data ● Adapt their approaches to practical work to control risk by consulting appropriate resources and expert advice ☑	**Across a range of contexts and practical situations pupils:** ● Propose scientific explanations for unexpected observations or measurements, making allowances for anomalies ● Process data, including using multi-step calculations and compound measures, to identify complex relationships between variables ● Critically interpret, evaluate and synthesise conflicting evidence ● Suggest and justify improvements to experimental procedures using detailed scientific knowledge and understanding and suggest coherent strategies to take particular investigations further ☑
Level 7	**Across a range of contexts and practical situations pupils:** ● Make explicit connections between abstract ideas and/or models in explaining processes or phenomena ● Employ a systematic approach in deciding the relative importance of a number of scientific factors when explaining processes or phenomena ● Explain how different pieces of evidence support accepted scientific ideas or contribute to questions that science cannot fully answer ● Explain the processes by which ideas and evidence are accepted or rejected by the scientific community ☐	**Across a range of contexts and practical situations pupils:** ● Suggest ways in which scientific and technological developments may be influenced ● Explain how scientific discoveries can change worldviews ● Suggest economic, ethical/moral, social or cultural arguments for and against scientific or technological developments ● Explain how creative thinking in science and technology generates ideas for future research and development ☐	**Across a range of contexts and practical situations pupils:** ● Explain how information or evidence from various sources may been manipulated in order to influence interpretation ● Effectively represent abstract ideas using appropriate symbols, flow diagrams and different kinds of graphs in presenting explanations and arguments ● Explain how scientists with different specialisms and skills have contributed to particular scientific or technological developments ☐	**Across a range of contexts and practical situations pupils:** ● Formulate questions or ideas that can be investigated by synthesising information from a range of sources ● Identify key variables in complex contexts, explaining why some cannot readily be controlled and planning appropriate approaches to investigations to take account of this ● Explain how to take account of sources of error in order to collect reliable data ● Recognise the need for risk assessments and consult, and act on, appropriate sources of information ☐	**Across a range of contexts and practical situations pupils:** ● Explain how data can be interpreted in different ways and how unexpected outcomes could be significant ● Identify quantitative relationships between variables, using them to inform conclusions and make further predictions ● Assess the strength of evidence, deciding whether it is sufficient to support a conclusion ● Explain ways of modifying working methods to improve reliability ☐
BL	☐	☐	☐	☐	☐
IE	☐	☐	☐	☐	☐

Key: BL-Below Level IE-Insufficient Evidence

Overall assessment (tick one box only) Low 7 ☐ Secure 7 ☐ High 7 ☐ Low 8 ☐ Secure 8 ☑ High 8 ☐

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