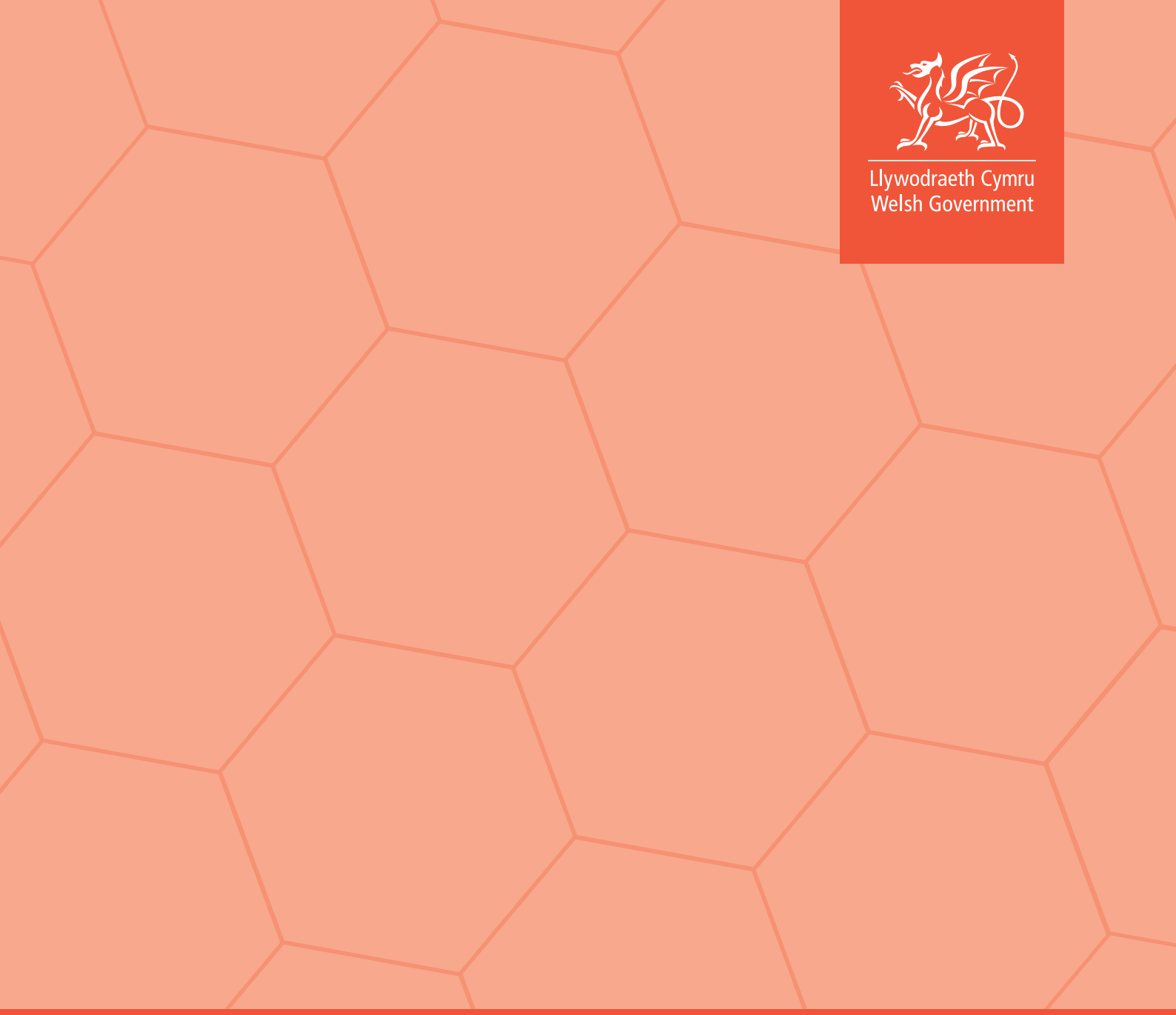

Llywodraeth Cymru
Welsh Government

Exemplification materials at Key Stages 2 and 3 in science

Additional guidance for Level 4

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Audience

Primary and secondary headteachers and heads of departments of maintained schools; secondary assessment coordinators and teachers at Key Stages 2 and 3; governing bodies of mainstream schools; local authorities; regional consortia; national bodies with an interest in education; tutors in initial teacher training; and others with an interest in continuing professional development.

Overview

The materials consist of examples of learners' work and a written commentary, which exemplify the standards set out in the national curriculum level descriptions. They illustrate how to use level descriptions to make best-fit judgements at the end of Key Stages 2 and 3, and give a justification and explanation for the level awarded.

Action required

To review learning plans and activities, and to prepare to make the required judgements at the end of Key Stages 2 and 3.

Further information

Enquiries about this document should be directed to:
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Additional copies

This document can be accessed from the Welsh Government's website at gov.wales/learning

Related documents

Exemplification materials at Key Stages 2 and 3 in science: Additional guidance for Level 5 (2017); *Exemplification materials at Key Stages 2 and 3 in science: Additional guidance for Level 6* (2017); *Science in the National Curriculum for Wales* (2008); *Science: Guidance for Key Stages 2 and 3* (2009); *Ensuring consistency in teacher assessment: Guidance for Key Stages 2 and 3* (2008); *Making the most of assessment 7–14* (2010)

This document is only available in English.

 WG32489 Digital ISBN 978 1 78859 267 3

Contents

Introduction

When teachers make summative judgements in science, the science skills are broken into 14 separate strands covering communication and enquiry skills, including planning, developing and reflecting. This science subject portfolio has been designed to exemplify the standards for each of the 14 science assessment strands that are available on the *Strands in progression from the level descriptions for science Key Stages 2 and 3* (learning.gov.wales/docs/learningwales/publications/140624-science-standards-of-progression-poster-en.pdf).

The materials here include a mixture of full and part investigations, alongside other transient skills that have been captured, e.g. learner–teacher dialogue, individual graphs and examples of learners' research findings. In the process of exemplifying the 14 strands, we have attempted to include a range of enquiry types, e.g. fair testing, classifying and identifying, and using and applying models. However, these materials are not designed to exemplify the full range of enquiry types. More information on science enquiry types are contained with *Science: Guidance for Key Stages 2 and 3* (learning.gov.wales/docs/learningwales/publications/140624-science-in-the-national-curriculum-guidance-en.pdf).

These materials are a collection of samples of work from different learners. They are not designed to present a coherent progression of the work of one learner. However, some of the tasks are used as source material for different skill strands. This demonstrates how one enquiry task may be used to enable teachers to develop multiple science skills. Although it is effective to teach science skills discretely, learners will require opportunities to draw together these skills in whole investigations as they work more independently.

The materials consist of examples of learners' work as well as written commentaries which give justifications and explanations for the level awarded. The audience for this work includes teachers working at Key Stages 2 and 3 and those working within a school to moderate and verify judgements. The examples in this document are for Level 4.

Examples of work will have errors that reflect the level being exemplified and some errors will not have been highlighted by teachers, where that aspect is not the focus of the marking.

Example 1

Subject portfolio:	Science
Task:	Researching light and researching the human body
Illustrative of characteristics at:	Level 4
Skill assessed:	*Find evidence, information and ideas*

Context

During work on the human body and light, the learner was challenged to apply their research skills to find evidence, information and ideas.

Following a series of lessons on the properties of light, the learner was asked to compile a fact sheet, drawing on information they had been taught as well as information gathered from the internet.

As part of work done on the heart and exercise, the learner was asked to find out about five organs in the human body and explain, using some scientific vocabulary, the function of the chosen organs. The learner worked independently on this task and gathered information from a science education website and books. They presented their findings in a tabulated format using text and images.

Comments

1. The learner works independently to *find and use a variety of evidence, information and ideas*. The learner uses scientific information to explain what they have found out and understood.
2. Although the learner retrieves information in response to the questions posed, some of the information is not directly related to the question set and/or has not been fully understood, e.g. the relevance of tattoos and body piercing.

Next steps

- To achieve Level 5 characteristics, the learner now needs to ensure that they search for more relevant information and ideas from a range of sources, as opposed to one website source.
- The learner now needs to show that they understand all the information selected.

The Human Body

Organ	What it does (function)
Heart	Pumps blood around the body. The heart is actually a large muscle that beats to a rhythm. This rhythm is our pulse and it increases to pump more blood around the body as we exercise.
Lungs	The lungs are made up of two organs that get filled with air. We breathe using our lungs and it helps oxygen enter our body.
Liver	This is a large organ that helps control the sugar in our body and removes dangerous chemicals.
Brain	The brain helps you control your body and lets you think!
Skin	This is the largest organ. It protects your body and keeps liquid inside. Some people change their skin by using tattoos and piercing their ears or nose!

During an evaluation of the task, the teacher discussed the pupil's work:

Teacher: You've found out some very useful information here on the human body. Some of this has not been in our class work so far. Where did you find the information?

Pupil: I went to several science websites that were useful, but in the end I found the science encyclopaedia the most useful to define the liver and skin.

Teacher: Why did you include the information on tattoos and body piercing in the skin section? Are they important scientific aspects?

Pupil: Not really. I just thought it was interesting to mention that some people change their skin using tattoos and piercings.

Teacher: Let's turn to your light sources fact file. Are there any things you recorded that you don't understand?

Pupil: Yes, I don't really think I really understand what black holes are.

Example 2

Subject portfolio:	Science
Task:	Investigating speed
Illustrative of characteristics mainly at:	Level 4
Skill assessed:	*Methods and strategies*

Context

As part of the class topic on motion, learners were challenged to investigate how the height of a ramp affects the speed of a toy car rolling down under the force of gravity. Learners were asked to plan a scientific enquiry in small groups, with one learner (the writing manager) responsible for presenting the idea to the class. This evidence presented here only relates to the initial prediction, plan and identification of variables.

Comments

1. The learner shows the ability to plan a fair test enquiry using scientific knowledge and skills, e.g. they use the terms 'variables' and 'prediction' accurately. The plan is logical and coherent, although it lacks some key details about how the task will be undertaken, such as how, exactly, the learner will use the mobile phone video to record the time taken to travel the set distance.
2. The learner uses scientific knowledge and skills to describe how they will carry out the work.
3. Although the learner's awareness of fair testing also shows some characteristics of Level 5 (*identify key variables and distinguish between independent and dependent variables and those they will keep the same*), overall the work lacks other important Level 5 aspects such as a systematic layout with bullet points or numbering of steps.

Next steps

- The learner needs to provide more detail about how the ramp will be raised (e.g. only raising one end of the ramp at a time). This could be communicated by writing scientific plans using bullet points or numbers so that the instructions appear as a series of systematic steps.
- In the next lesson, a conclusion should be included that explains the relationship between the independent and dependent variables (including accurate use of scientific vocabulary).

Investigating Speed

Aim
To find out how the height of a ramp affects the speed of a trolley rolling under gravity.

Prediction
My prediction is that the higher the ramp the faster the trolley will travel down the ramp. The trolley will travel down the ramp under the force of gravity on its way down the ramp (and the trolley will also have a friction force acting on it).

Method
I will change the height of the ramp 5 times. The ramp heights will be: 10cm, 20cm, 30cm, 40cm and 50cm. I will measure the speed of the trolley using a mobile phone video. I will play the video back to calculate the time taken to travel 50cm from the bottom of the ramp. I will make sure we use a smooth surface at the bottom of the ramp. I will repeat the trolley from each height to double-check the results.

Fair test
To keep this investigation fair I plan to control the following variables:

Change: height of the ramp
Measure: speed (time taken to travel 100cm from the end of the ramp)
Keep the same (control): same trolley; same ramp length and surface; same start place for the trolley; same floor surface.

Example 3

Subject portfolio:	Science
Task:	How does the temperature of water affect the mass of salt that dissolves?
Illustrative of characteristics at:	Level 4
Skill assessed:	*Predict*

Context

As part of a unit of work on materials, learners were asked to investigate how different substances dissolve in water. After an initial period of exploration, the learner chose to plan a fair test enquiry to find out how the temperature of water affects the amount of salt that dissolves. This included a prediction, a list of apparatus required and an outline method for the enquiry.

Comments

1. The learner shows the ability to predict using *scientific knowledge and skills to…predict outcomes*, including a clear reference to the quantity of salt and the temperature of the water.
2. The learner identifies the variables to change and measure, and also plans the method using scientific knowledge and skills.

Next steps

- The learner now needs to make predictions using more comparative language, e.g. ‘the warmer the water, the greater the mass of salt that will dissolve’. This is a Level 5 characteristic.
- The learner could be encouraged to explain their ideas using a simple model of change of state (a Level 5 characteristic).

How does the temperature of water affect the mass of salt that dissolves?

Prediction

I predict that the amount of salt that will dissolve in the water will increase when the temperature of the water increases. It will happen because heat always makes things change quicker, e.g. melting chocolate.

Fair test

I will change the temperature of the water.
I will measure the number of spatulas of salt that can be dissolved in the water.
I will keep the same volume of water; size/type of beaker; spatula; type of salt.

Method

- Pour 50ml of water into the beaker.
- Heat the water up using a Bunsen burner, tripod, gauze and heat proof mat. I will heat the water to 20, 30 and 40 degrees Celsius.
- I will keep the beakers at the same temperature using a water bath.
- Stir in spatulas of salt into the water until the salt will no longer dissolve.
- I will record the results in a table. I will repeat the operation three times at each temperature to check my results.

Example 4

Subject portfolio:	Science
Task:	Investigating a clockwork toy
Illustrative of characteristics at:	Level 4
Skill assessed:	*Fair testing*

Context

The learner was asked to investigate how the number of turns used to wind up a clockwork toy affects how far the toy would then travel. The teacher explored learners' ideas as to whether doubling the number of turns of a clockwork toy will double the distance it travels. After the group discussion, the learner produced an independent scientific plan, including some information about how the fair test would be controlled. The work was used to exemplify the learner's ability to identify and manipulate variables.

Comments

1. In this plan the learner identifies the independent variable which can be changed (number of turns) and the dependent variable they intend to measure (the distance travelled). They also identify the control variables (type of toy and surface).
2. The learner also chooses standard equipment to measure the distance travelled (measuring tape).

Next steps

- The learner now needs access to tasks that provide more opportunities to identify and control a greater number of key variables, e.g. fair tests that require the learner to identify a range of important variables before they select one independent and one dependent variable to change and measure respectively (a Level 5 characteristic). These tasks should also require the learner to identify a wider range of control variables.

Investigating a clockwork toy

Aim

We are going to find out how the distance travelled by a clockwork toy depends on how much it has been wound up.

Fair Test

To make sure it is a fair test i will not change the toy or the surface because it would change the result. i will only change the number of times i turn the toy.

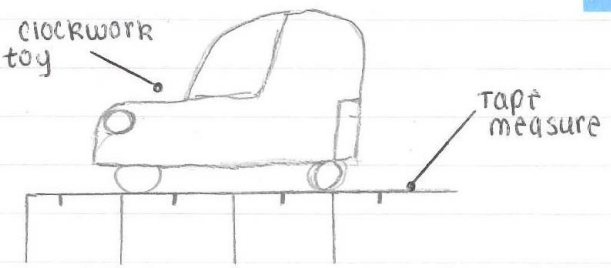
Prediction

I think that doubling the turns will double the distance travelled by the toy. The more turns the further it will go.

List of apparatus

1. Clockwork Toy
2. Tape measure

Diagram



Recognise, with support, the variables to change and measure and those to be kept the same.

Use scientific knowledge and skills to plan their enquiries....

Example 5

Subject portfolio:	Science
Task:	Determining success criteria
Illustrative of characteristics at:	Level 4
Skill assessed:	*Determine success criteria*

Context

Prior to this task, learners were taught how to identify different types of success criteria during their scientific work, e.g. science enquiry process skills and outcome success criteria. During the subsequent lessons, learners were challenged to discuss what type of success criteria might be appropriate when creating a science plan and when building a burglar alarm. The example is the written work of one Year 6 learner. The teacher circulated among the groups of learners to assess their responses.

Comments

1. The learner identifies four success criteria for a successful plan when conducting an enquiry. These are: to form a prediction using the variables we plan to change and measure; write the instructions as steps and include bossy verbs to start each sentence; include all the important details in the method (use numbers or bullet points); and use scientific vocabulary.
2. The learner decides *upon some basic success criteria* for a successful burglar alarm, i.e. as well as a circuit diagram, the alarm needs a force-operated switch and to give off light and sound.

Next steps

- The learner now needs to justify their selection of success criteria, e.g. ‘write the instructions in steps so that it’s easy for somebody else to repeat the work and check the results’ (a Level 5 characteristic).

Creating a science plan

***Objective**: To create a science plan*

You now need to identify your success criteria for this task:

Our success criteria

1. *Form a prediction using the variables we plan to change and measure.*
2. *Write the instructions as steps and include bossy verbs at the start of each sentence.*
3. *Include all the important details in the method (use numbers or bullet points).*
4. *Use scientific vocabulary.*

Designing a burglar alarm

***WALT**: To design and make burglar alarm*

You now need to identify your success criteria for this task:

WILF (success criteria):

1. Include a switch that is operated by force (e.g. somebody stepping on a mat)
2. The alarm needs to give off light and sound
3. Produce a simple circuit diagram in the plan.

Example 6

Subject portfolio:	Science
Task:	Investigating how the sole affects the force needed to pull the shoe
Illustrative of characteristics at:	Level 4
Skill assessed:	*Observe and measure*

Context

As part of a topic on forces, learners produced a plan to investigate how the type of sole on a shoe affects the friction it produces. The learner shared ideas within a small group, then produced a method and carried out the investigation with a partner. While the learner's work illustrates a number of characteristics, the teacher's primary focus was on the learner's ability to *observe and meas*ure. The teacher also assessed the learner's skill in *explaining,* i.e. how the property of a surface (texture) affects the friction required to move an object. The teacher discussed ways of measuring force using a forcemeter.

Comments

1. The learner follows the planned method and makes a series of accurate measurements with a forcemeter.
2. The learner's work indicates they understand that a newton (N) is the unit of force.
3. In the example the learner uses basic scientific vocabulary to explain their findings, e.g. 'friction', 'newton'.

Next steps

- In order to show characteristics of Level 5 in this example, the learner needs to identify that objects with a larger mass, and/or travelling over rougher surfaces, may require a forcemeter capable of measuring a higher force.
- The learner needs to demonstrate that they are able to make a series of accurate measurements with different scales (a Level 5 characteristic).
- The learner also needs the opportunity to explain their findings using simple models. In the case of the forces enquiry task, they could create a simple force diagram (not to scale) that indicates the relative size of the frictional forces of the object on different surfaces. They could explain that friction is a force and that it works in the opposite direction to the pull.

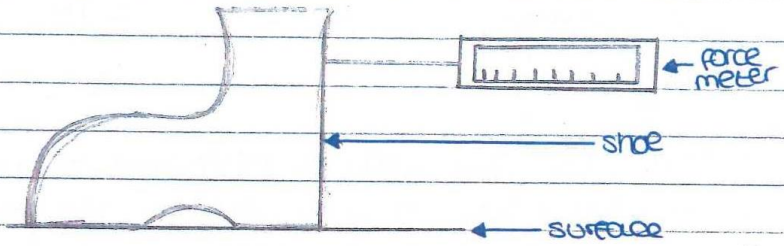
Aim

I will investigate how the sole affects the force needed to pull the shoe

Apparatus

- Force meter, 1kg mass, 5 shoes, table

Diagram



Fair test

The variables in this investigation are...

- The shoe
- The weight
- The surface

✓ Describes how to control a fair test.

To make sure it is a fair test I will keep the same surface but change the sole of the shoe.

Method

- We got into groups and got 5 shoes to use in our experiment. We the drew a table to write our results in. We placed 1kg mass in the first shoe and attached a force meter to the shoe, we then measured how much force was needed to pull each shoe. To make it a fair test we used the same person to pull each shoe we used, the same force meter, surface and mass.

RESULTS:

Shoe	Force needed (N)
Flat sole (rubber)	3·4N
Mini rubber heal	0·5N
Metal spikes	0·7N
Plastic studs	2·1N

conclusion

The flat rubber sole needs the most force. This was because the rubber sole had the most friction. The mini rubber heal did not have a very good grip, it didn't need much force at all to pull it.

Improvements

We should have repeated all our results to get more reliable results. We didn't do this because there was no time left, we could do it next time.

✓ Able to draw conclusions from findings
✓ Able to relate these outcomes to scientific knowledge
✓ Suggests how to improve their work.

(Level 4 aspects)

Example 7

Subject portfolio:	Science
Task:	How does the height of the drop affect the bounce of a ball?
Illustrative of characteristics mainly at:	Level 4
Skill assessed:	*Monitor progress*

Context

This is a group task where learners carried out an enquiry to investigate the motion of bouncing balls. In particular, the teacher challenged the class to consider whether a ball dropped from twice the height will always bounce twice as high. After discussing the task with a small group, the learner created a plan (including the identification of key variables, equipment and a method). Although the teacher's primary focus is on assessing the learner's ability to *monitor progress*, the skill of *communicating findings* was also assessed.

Comments

1. Monitoring progress refers to the skill of reviewing the scientific process during an investigation. This may involve an awareness that the learner needs to change or alter any aspect of the enquiry being undertaken, e.g. swapping equipment, identifying additional control variables or increasing the number of repeat measurements to improve reliability.
2. In this example, the learner makes amendments during the practical work to improve the accuracy of the height measurements, i.e. using a visual marker for the height of the bounce as opposed to catching the ball. As well as correcting their method during the course of the work, they also record these amendments onto their plan. Level 5 was not considered for the *monitor progress* skill as the learner has not been observed regularly revising methods over a variety of tasks.
3. The learner produces a well-organised written method using appropriate scientific language, e.g. 'gravitational pull', 'mean'. They tabulate data and produce a simple sketch to explain their ideas using scientific knowledge.
4. The learner also draws a line graph independently (a Level 5 characteristic).

Next steps

- The learner could be encouraged to identify their own suggestions to improve their method and to identify the most appropriate type of graph to display the data they have collected (both Level 5 characteristics).

Tuesday 14th June 2016

Aim: How does the height of the drop affect the bounce of a ball?

Fair Test:

To make this a fair test, we will be only changing one variable which would be the height of the ball dropped from.

Independent variable:

We will change the height the ball is dropped from.

Dependent variable:

We will measure the height of the bounce from the ball.

Equipment:

- Tennis ball
- chair
- clipboard
- meter stick
- paper
- pen / pencil

Method:

Step 1 - Get the equipment needed.

Step 2 - Measure 20 cm.

Step 3 - Drop the ball at 20 cm, and catch it.

Step 4 - Measure and record it.

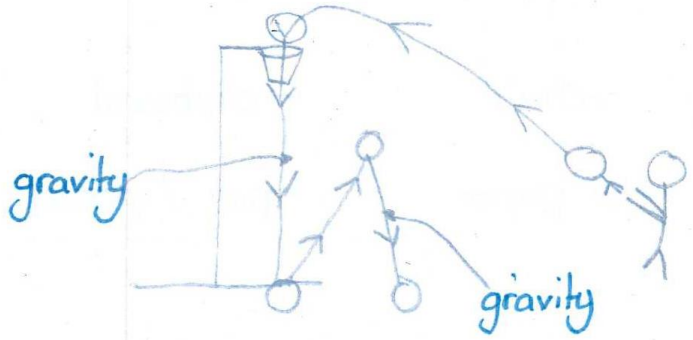
Step 5 - Repeat this until it gets up to 1m 60cm. (go up in 20 cm)

* When we came to doing our method we changed it slightly instead of us catching it we lyed on the floor and looked were the ball reache

When we were catching the ball we were catching it wrong which was giving us wrong results.

Prediction:

I think the higher the ball is dropped from, the higher it will bounce. I think this because the higher it is the more gravitational pull it has. For example when I shoot in netball the gravity pulls it down causing me to score a goal.



What a great example to use! Super work.

Table of Results:

Hieght (cm)	Try 1	Try 2	Try 3	Total
20	13cm	12cm	11cm	12
40	21cm	20cm	21cm	20.6
60	28cm	28cm	31cm	29
80	39cm	38cm	40cm	39
100	45cm	44cm	49cm	48
120	55cm	55cm	54cm	54.6
140	57cm	63cm	60cm	60
160	68cm	72cm	69cm	69.3

Accurate measuring and recording
Mean average

Conclusion:

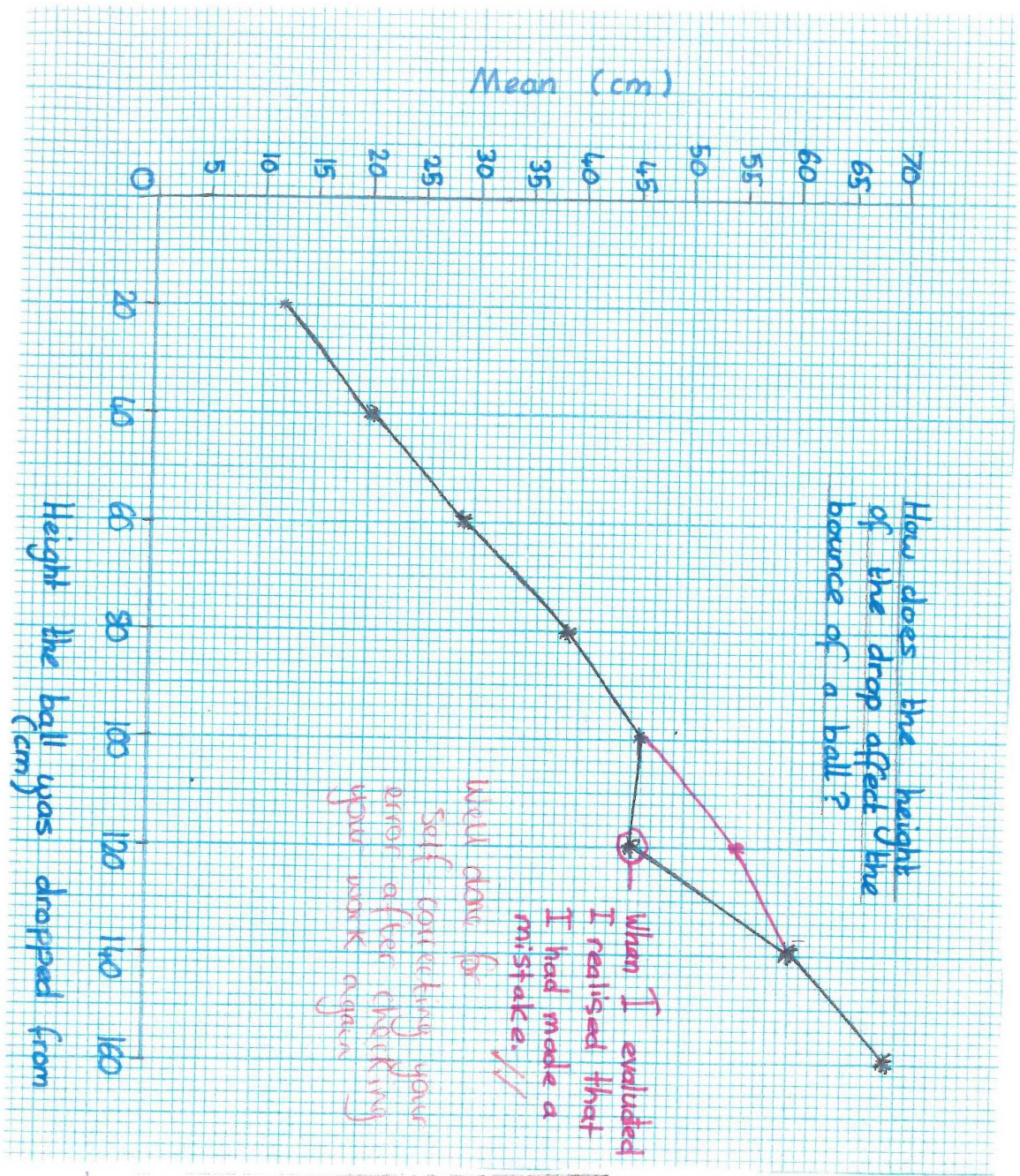
our results show that the higher the ball is dropped, the higher it will bounce. When the ball was dropped at 20cm it only bounced 12cm, but when it was 160cm it bounced 69.3cm. When it was high, gravity had more of pull over it. When it is higher it picks up more speed creating like a run up, to bounce.

I really like how you've explained this.

Evaluation:

At the end of our experiment we are very happy with our work. I would rate it 9/10. Next time we could improve on the distance the ball was dropped from. If we did do this it would give us more results.

Graph:



S.C To make a line graph	✓×
Lable axes	✓
Give the graph a title	✓
Spread numbers evenly	✓
Small cross on plot point	✓

Example 8

Subject portfolio:	Science
Task:	How does the height of the drop affect how high a ball bounces?
Illustrative of characteristics mainly at:	Level 4
Skill assessed:	*Communicate findings*

Context

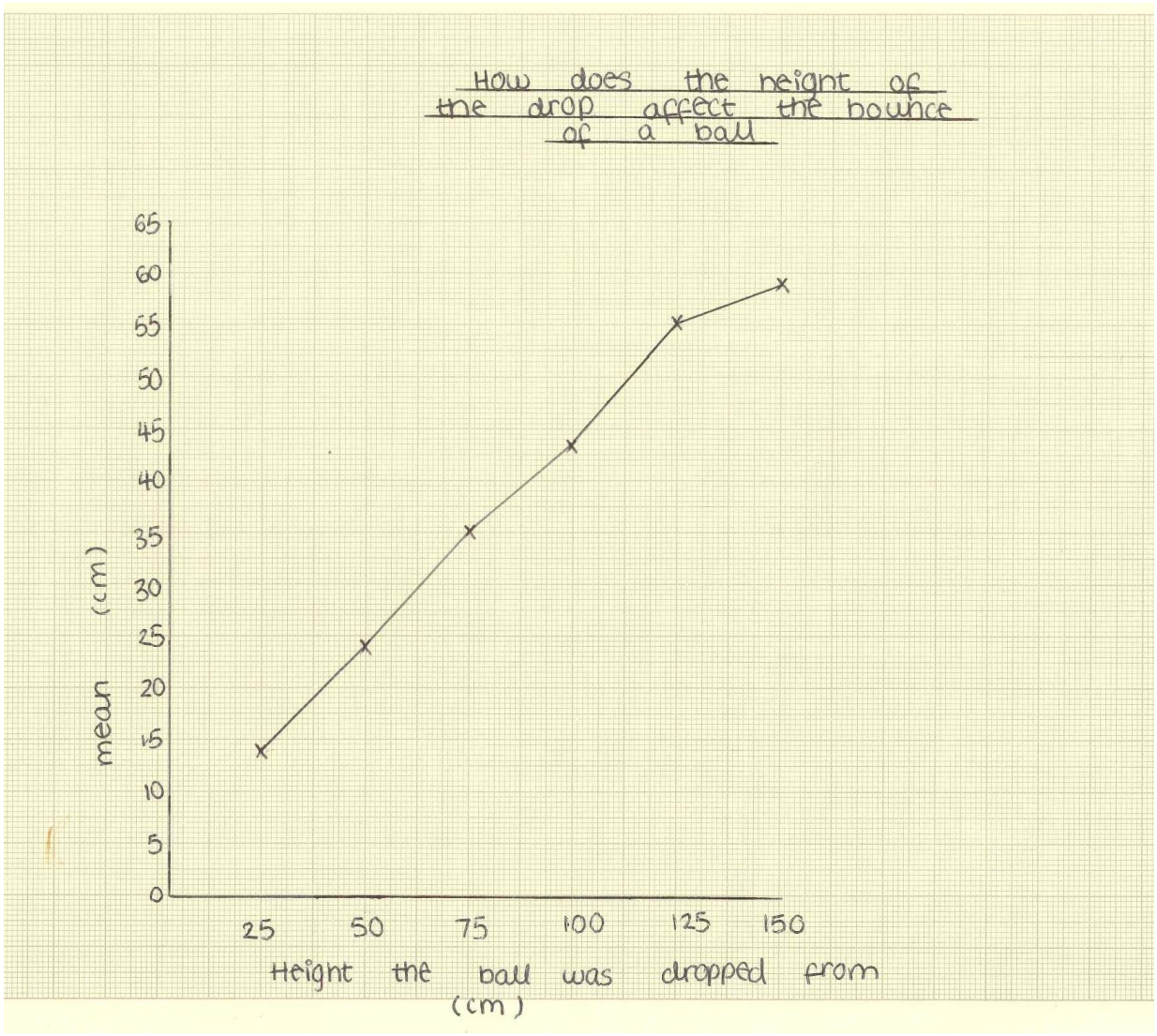
This is a group task where learners carried out an enquiry to investigate the motion of bouncing balls. In particular, the teacher challenged the class to consider whether a ball dropped from twice the height will always bounce twice as high. After discussing the task with a small group of peers, the learner created a plan that included information on key variables, equipment and the method. During this task the teacher focused on assessing the learner's ability to *communicate findings.*

Comments

1. The learner shows they can *organise and communicate their findings using relevant scientific language and display these in tables…and in simple line graphs when the axes and scales are given.* They produce a well-organised scientific plan, including appropriate vocabulary and tabulated data.
2. The learner also constructs a line graph with support from the teacher. The teacher helps the learner to construct the line graph by providing guidance about axes and scales.
3. In the table of results, the learner shows an awareness of the need to repeat readings to improve the reliability of their work (a Level 5 characteristic).

Next steps

- The learner now needs to identify the most appropriate type of graph to display the data they have collected (a Level 5 characteristic). This may take the form of a discussion about the use of a line graph to display two continuous variables.


How does the height of the drop affect the bounce of a ball
mean (cm)
65
60
55
50
45
40
35
30
25
20
15
10
5
0
25
50
75
100
125
150
Height the ball was dropped from (cm)

Tuesday 14 June 2016

Aim - How does the height of the drop affect how high a ball bounces.

Fair test - We will only change the height from where we drop the ball.

all main factors

Equipment - We need to use:
A tennis ball, a chair, a metre ruler, pen, paper, clipboard.

Method
① Drop the ball from 25cm and measure the height of the bounce.
② Drop again from 50cm and measure the bounce.
③ Carry on, increasing the hight up to 1m 25cm.

Prediction - I think the higher we drop the ball the higher it will bounce.

-er words in prediction!

Results

Height of drop (cm)	Try 1	Try2	Try3	Median bounce (cm)
25	14cm	13cm	15cm	14
50	25cm	23cm	24cm	24
75	36cm	33cm	35cm	35
100	41cm	43cm	44cm	43
125	53cm	53cm	52cm	53
150	62cm	60cm	61cm	61

Conclusion and Explanation

We can see from our results that the higher drops gave us the highest bounces. The ball dropped at 25cm bounced to 14cm up the wall. The ball dropped from 1m bounced to 43cm up the wall. The results are very clear. I think this happens because the ball travels faster from a height and ~~bounces~~ causes more bounce force.

✓ You planned using scientific skills and vocabulary
✓ You used a table of data and worked out the median.

Example 9

Subject portfolio:	Science
Task:	Graphs: rocket balloons and paper spinner
Illustrative of characteristics mainly at:	Level 4
Skill assessed:	*Review findings*

Context

During a discussion on graphing data, the teacher has used evidence from previous practical tasks to teach learners the skills required for the *review findings* skill. During this session, the teacher shared examples of varying quality and established some key success criteria for learners to use when identifying patterns and trends in their findings at Level 4, including:

- does your description refer to the variables you changed and measured?
- does your description refer to the overall pattern in your findings?

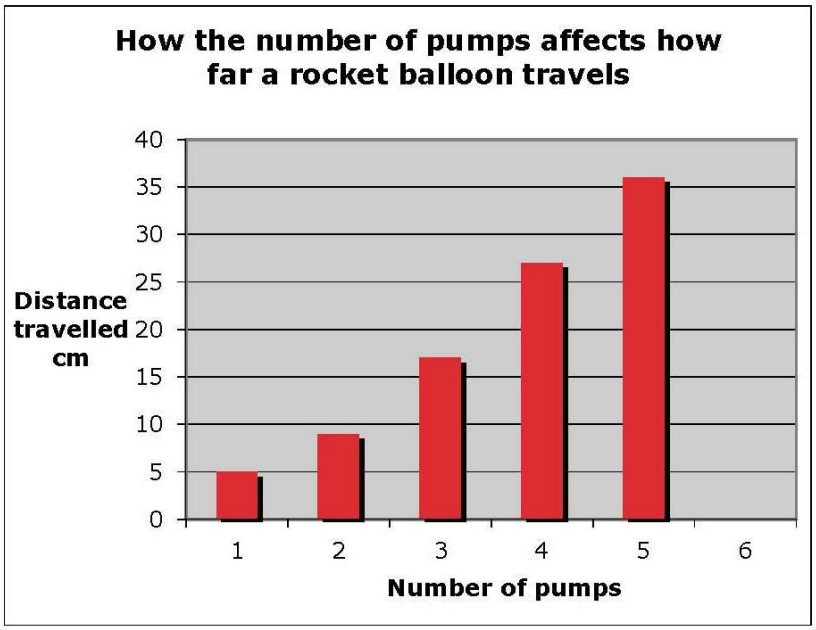
There is a bar graph (rocket balloons) and a line graph (paper spinners), each with a comment to show the learner has identified patterns and trends in graphs.

Comments

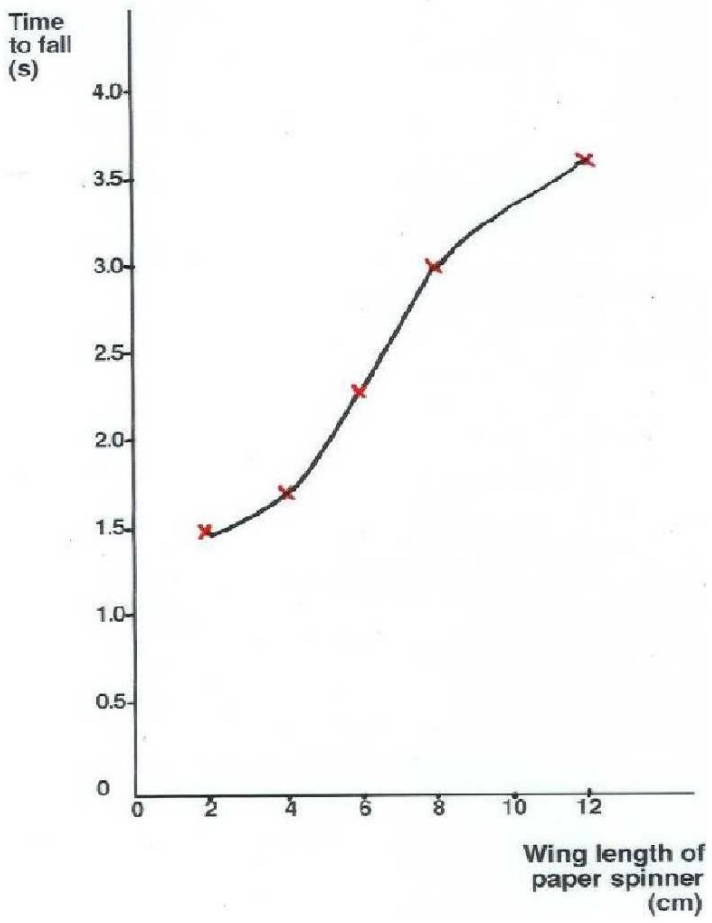
1. The learner describes the basic relationship between the key variables in the two examples ('more pumps send the rocket further' and 'longer wings take a longer time to fall'). Descriptions at Level 4 commonly involve associations between independent categorical and dependent continuous data, i.e. variables as objects versus variables represented by numbers.
2. For both graphs, the learner explains to the teacher why the data has been displayed as a bar and line graph respectively (a Level 5 characteristic), e.g. 'the paper spinner graph needs to be a line graph because both time and length data are continuous data'.

Next steps

- The learner now needs to use more comparative language when describing the relationship between variables, e.g. 'the greater the number of pumps, the further the rocket will travel', or 'the longer the wings of the paper spinner, the greater the time taken to fall to earth' (both Level 5 characteristics).



Comment: *more pumps send the rocket further.*



Comment: *spinners with longer wings take a longer time to fall*

Example 10

Subject portfolio:	Science
Task:	Sticky tape investigations
Illustrative of characteristics at:	Level 4
Skill assessed:	*Explaining*

Context

As part of a topic on forces, learners produced a plan to investigate which type of sticky tape requires the most force to remove it from a surface. The learners initially shared ideas within a small group, then planned and carried out the investigation in pairs. The teacher used the sample of work here to assess learners' ability to explain the pattern in their findings.

Comments

1. The learner understands and uses basic scientific vocabulary to explain their findings, e.g. the term 'newton'. In this example the learner also understands the concept of force as a push or pull acting upon an object.
2. In their conclusion, the learner also shows an understanding of friction as a force that opposes the movement of an object.
3. Throughout this task, the learner demonstrates they are able to *use scientific knowledge and skills to plan their enquiries and predict outcomes* and *use standard equipment to measure within a given range using S.I. units* (a Level 4 characteristic).

Next steps

- The learner now needs the opportunity to explain their findings using simple models in other tasks. In the example here, the learner could be encouraged to create a simple force diagram (not to scale) indicating the direction of the forces acting on the sticky tape.

Sticky tape investigations

Aim:
I will investigate the force required to pull different brands of sticky tape from a flat surface. We want to find out which brand is the stickiest.

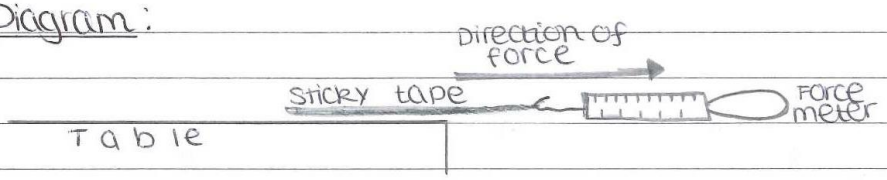
Prediction:
I predict that the duct tape will need the most force to pull it off the table. I think the masking tape will be the weakest.

✓ Simple prediction.

Equipment:
Forcemeters, table, duct tape, celotape, masking tape and results table to record findings.

✓✓

Diagram:



Fair test:
We will change the tape.
We will measure the force (N) to pull the tape.
We will keep the same forcemeter, flat table and same length of tape each time.

✓✓ Describes how to control a fair test.

Method:

① We cut equal lengths of tape from each of the three types.
② We stuck 5cm of tape onto the ~~tape~~ table and wrapped the other end around the forcemeter hook
③ We pulled the forcemeter until the tape popped off the table.
④ We wrote down how much force was needed to make the tape pop off the table.

Results:

Tape	Force needed (N)
Cellotape	7
Duct tape	9
Masking tape	5

✓✓ drew table and correct units used.

Conclusion:

The duct tape needed most Newtons to pull it off. This was because it seemed to be more gluey and we think this because we needed more pulling force. We don't think this was friction force because the tapes didn't move on the table.

✓✓ using scientific vocabulary to explain.

Review:

We think we need to repeat our measurements because it was hard to see the newtons when the tape popped off the table.

(Level 4 aspects) ✓ Able to draw conclusions from findings
✓ Able to relate these outcomes to scientific ideas.

Example 11

Subject portfolio:	Science
Task:	Crazy conkers
Illustrative of characteristics at:	Level 4
Skill assessed:	*Conclusions and decisions*

Context

Following a series of lessons on gravity and air resistance, learners explored the motion of falling objects, including parachutes and paper aeroplanes. The teacher then introduced learners to the concept of a pendulum (through the context of 'crazy conkers') and asked learners to identify a testable question to investigate. Learners in one group identified the following question: 'If we double the mass of a conker, will it swing twice as fast or twice as slow?'

The teacher's main focus was to assess the learners' ability to arrive at *conclusions and decisions*. After completing the task and evaluating their findings, the teacher then challenged the learners to link their learning to other contexts. The sample of work here is from one learner who acted as the writing manager during the task. During questioning, the teacher judged that this learner had a good grasp of the material they had written.

Comments

1. The learner forms a simple conclusion by referring to both the pattern in the data and a basic scientific explanation, i.e. the fact that gravity has the same effect regardless of the mass of the conker. This task has not provided the opportunity for the learner to describe the relationship between continuous variables (a Level 5 characteristic).
2. The learner discusses ideas and results with other learners to check how far their findings can be reproduced.
3. The learner also uses correct scientific terminology, e.g. 'mass'.

Next steps

- The learner now needs the opportunity to draw conclusions from relationships using two continuous variables, e.g. the length of the conker string and the time taken to swing from one side to the other (a Level 5 characteristic).
- As well as forming conclusions that are consistent with their findings, the learner now needs opportunities to show they work collaboratively and consider others' views over a number of tasks (a Level 5 characteristic).
- The learner needs to make a link to dissimilar but familiar situations, e.g. drawing a comparison between the motion of the pendulum and free falling objects (a Level 5 characteristic).

Crazy Conkers

What we did

In the previous lesson we were looking at the behaviour of 'crazy conkers'. We were asked to choose a question to investigate, then plan and carry out the task. Our question was: If we double the mass of a conker, will it swing twice as fast or twice as slow?

We added a 2p coin into a paperclip at the bottom of a string. We then released it from a horizontal starting point and counted the number of full swings in 20 seconds. We then repeated this each time by adding another 2p coin into the paperclip. We repeated each mass three times to check our results.

Results

Number of coins	Number of swings in 20 seconds 1st attempt	Number of swings in 20 seconds 2nd attempt	Number of swings in 20 seconds 3rd attempt	Median number of swings in 20 seconds
1	17	16	17	17
2	16	17	16	16
3	17	17	18	17
4	18	16	17	17

Our findings tell us that adding more mass doesn't change the number of swings much at all.

Conclusion

I found out that changing the number of coins (mass) of the conker does not affect the number of swings. The results for the four different coins are very similar – they all had between 16 and 17 swings in 20 seconds. We were convinced that the conker would either speed up or slow down as we increased the amount of coins. It seems that gravity has the same effect whatever the mass of the conker (so it gives the same number of swings).

Example 12

Subject portfolio:	Science
Task:	Planning a fair test and building a burglar alarm How does the height of the drop affect the bounce of a ball?
Illustrative of characteristics at:	Level 4
Skill assessed:	*Review success*

Context

As part of a class topic on electricity, learners explored how the design and number of components in a simple circuit affected the loudness of a buzzer. Learners then investigated how these components might be used to construct a simple burglar alarm (a making things enquiry type).

Learners then carried out a fair test enquiry to investigate the motion of bouncing balls. The teacher challenged the class to consider whether a ball dropped from twice the height will always bounce twice as high. After discussing the task with a small group of peers, the learner created a plan that included information on key variables, equipment and a method.

After completing both enquiry tasks, each learner was asked to evaluate the quality of their work, including an evaluation of progress against their initial success criteria. The evaluation commentary added to the initial success criteria for both tasks is the independent work of one learner.

Comments

1. The examples show the learner identifying success criteria for two purposes, specifically:
   - outcome success criteria (i.e. the key features and/or functions for a successful burglar alarm)
   - science enquiry skills success criteria (i.e. the key science skills required to undertake a fair test enquiry).
2. In the 'Creating a science plan' and 'Designing a burglar alarm' examples, the learner reviews their progress against the initial success criteria.
3. In the investigation '*How does the height of the drop affect the bounce of a ball',* the learner states how they could improve their method by investigating the behaviour of the bouncing ball from a 2m drop height.

Next steps

- The learner now needs to evaluate progress fully against the initial success criteria, e.g. discussing the additional control variables that they recognised as an important part of the fair test enquiry and/or identifying how the loudness of

the burglar alarm could be increased by improving the design of the circuit (a Level 5 characteristic).

- The learner could also identify the learning and thinking strategies they have used, e.g. the need to follow a systematic planning format, including prediction, an equipment list and the identification of key variables, and a table to allow repeat readings to be recorded (a Level 5 characteristic).

Creating a science plan

***Objective**: To create a science plan*

You now need to identify your success criteria for this task:

Our success criteria

1. *Form a prediction using the variables we plan to change and measure.* Our prediction included the key variables.
2. *Write the instructions as steps and include bossy verbs at the start of each sentence.* I wrote the plan as numbered points
3. *Include all the important details in the method (use numbers or bullet points).* Yes, nothing was left out and the group nearby could follow our plan.
4. *Use scientific vocabulary.* I used science words

I could improve the investigation next time by making sure we remember to record our findings in a data table. Also, in the prediction I should have said 'the higher the drop, the higher the bounce' rather than 'the higher the drop the bigger the bounce'. James pointed that out to me!

Designing a burglar alarm

***WALT**: To design and make burglar alarm*

You now need to identify your success criteria for this task:

WILF (success criteria):

1. Include a switch that is operated by force (e.g. somebody stepping on a mat) Yes, it was small enough to fit under the mat and it worked.
2. The alarm needs to give off light and sound Yes, it flashes and buzzes.
3. Produce a simple circuit diagram in the plan. Yes, I created a circuit diagram with the correct symbols.

I could improve the investigation next time by adding another cell to the circuit to make it louder. As it was, the mat muffled some of the sound.

Example 13

Subject portfolio:	Science
Task:	How does the height of the drop affect the bounce of a ball?
Illustrative of characteristics at:	Level 4
Skill assessed:	*Evaluate learning*

Context

The learners worked as a team to carry out an enquiry. Each member of the team was given a specific aspect of the enquiry to manage on behalf of the group, e.g. measuring manager and equipment manager.

After completing the 'How does the height of the drop affect the bounce of a ball?' enquiry, the learners were asked to evaluate the quality of their work, including a reflection on how their learning progressed during the task. In this task the teacher focused on the *evaluate learning* skill.

Comments

1. The learner describes *how they have learned…* and how they…*identify the ways that worked the best* by explaining that working in a group with individual roles was an effective strategy.
2. The learner identifies that sharing ideas within the group has enabled the measuring manager to remind them about including sufficient columns in a table to allow repeat readings to be recorded. The learner also learned that they could use the median value when they take three repeat readings.

Next steps

- The learner now needs to identify the learning/thinking strategy they have used, e.g. they could identify the need to follow a systematic planning format (including a prediction, equipment list and the identification of key variables) as an effective strategy that helps them create a good-quality science plan.

Teacher: Tell me about how your group worked during your recent investigation, 'How does the height of the drop affect the bounce of a ball?'

Pupil: At the start of our enquiry work we gave each other jobs in the group, e.g. planning manager, equipment manager, recording manager. This worked really well, as we all had a job to do and nothing important was missed out. The recording manager even reminded us to repeat our readings each time we dropped the ball.

Teacher: What was your most effective learning strategy today?

Pupil: I think when we shared our knowledge around the group we all learned something new. For example, it was really useful to watch the measuring manager create his own table to record our findings. He reminded us that we need to have at least three columns to record our repeat readings. One of the group also mentioned that we could then take the median value if we didn't have time to calculate the mean.

Example 14

Subject portfolio:	Science
Task:	Crazy conkers
Illustrative of characteristics at:	Level 4
Skill assessed:	*Link learning*

Context

Following a series of lessons on gravity and air resistance, learners have explored the motion of falling objects, including parachutes and paper aeroplanes. The teacher has now introduced learners to the concept of a pendulum (through the context of 'crazy conkers') and has asked learners to identify a testable question to investigate. Learners in one group investigated the following question: 'If we double the mass of a conker, will it swing twice as fast or twice as slow?' After completing the task and evaluating their findings, the teacher challenged the learners to link their learning to other contexts.

Comments

1. During an exchange with the teacher, the learner makes a link from the outcomes of the task to a similar situation. They understand that increasing the mass of a pendulum in a clock will not affect the timekeeping of the clock.
2. The learner also uses correct scientific terminology, e.g. 'mass' and 'pendulum'.

Next steps

- The learner now needs to make a link to dissimilar but familiar situations, e.g. drawing a comparison between the motion of the pendulum and free-falling objects (a Level 5 characteristic).

Crazy Conkers

What we did

In the previous lesson we were looking at the behaviour of 'crazy conkers'. We were asked to choose a question to investigate, then plan and carry out the task. Our question was: If we double the mass of a conker, will it swing twice as fast or twice as slow?

We added a 5g mass (a 2p coin) onto a paperclip at the bottom of a string. We then released it from a horizontal starting point and counted the number of full swings in 20 seconds. We then repeated this each time by adding on more 2p coins to give a 10g, 15g and 20g mass. We repeated each mass three times to check our results.

Results

Mass of conker (g)	Number of swings in 20 seconds 1st attempt	Number of swings in 20 seconds 2nd attempt	Number of swings in 20 seconds 3rd attempt	Median number of swings in 20 seconds
5	17	16	17	17
10	16	17	16	16
15	17	17	18	17
20	18	16	17	17

Our findings tell us that adding more mass doesn't change the number of swings much at all.

Conclusion

I found out that changing the mass of the conker does not affect the number of swings. The results for the four different masses are very similar – they all had between 16 and 17 swings in 20 seconds. We were convinced that the conker would either speed up or slow down as we changed the mass. It seems that gravity has the same effect whatever the mass of the conker (so it gives the same number of swings).

Teacher: If you think about your results from today's task compared to a pendulum in a clock, what would happen to the clock if you added a heavier pendulum?

Pupil: I don't think it would change the clock's time keeping because changing the mass won't change the movement of the pendulum very much.