

Overview

Sunday, November 10, 2019 7:56 PM

Student Name: Thomas Parkin

Student Number: 1905225

Assignment Title: A portfolio which illustrates a critical reflection of progress made on the planning and implementation of three pedagogical principles.

Pathway: PGCE (Secondary) Physics QTS

Link to OneNote: https://uowtsd-my.sharepoint.com/:o:/g/personal/1905225_student_uwtsd_ac_uk/EpNI8N94DkZGh5hf62EcjSABMUZOvZbqz4EmOhw2zOzFQg?e=qq0ENX

Assessment for learning

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The following is an extract from a year 10 middle set physics lesson. This was the first time students had covered electricity within secondary school. The lesson was designed to give students the opportunity to draw accurate circuit diagrams as well as introduce the meaning of key terms (voltage, resistance, amplitude). The lesson had a particular focus on identifying circuit diagram symbols and having a rough idea of their use.

This is a section of the lesson plan which outlines the success criteria and assessment of learning.

Similar constraints and expectations for exams chosen, even at the initial stage to set consistent expectations for what is acceptable for drawing circuit diagrams

Success Criteria (clearly linked to each Learning Objective and related to the process and/or product of learning)	Assessment of Pupils' Learning Evidence (What have the learners to say/write/do/produce - to demonstrate learning)
• Straight lines, correct symbols in a timely fashion (for drawing circuit diagrams) • Able to discuss the terms and what they think they mean • Can identify the name of a component when shown the symbol	• Drawn circuit diagrams in book • Written down ideas on V, I, & R • Verbal discussion participation (either class wide or individually) • Participation in whiteboard quiz, identifying the symbols

This allows for some flexibility within the lesson to assess conversationally at what level they are accessing the topic. Allowing students to first write down their initial ideas, following with an informal class discussion enabled students to start to build confidence in a seemingly overwhelming and difficult section of the topic. This 'low stakes' approach to questioning expressed that the purpose was for determining at what stage students were at, not testing them

The focus of this example; the explicit use of AFL to determine the success of the lesson. This is especially useful at this stage as this lesson was the students' first time learning about electricity since primary school.

This is a portion of the PowerPoint slides used as part of an AFL plenary for the lesson. This took the form of a whiteboard quiz to quickly and efficiently determine the students' answers.

Electrical Circuits Quiz

Use the whiteboards in your planner to identify the following electrical components.

Use this time to try to remember the symbols on page 30

Resistor

Diode

AC Power supply

Fuse

Variable DC Power supply

Light Dependant Resistor

Thermistor

Light Emitting Diode (LED)

Students, as small groups, had determined the symbol for each component as well as their use from some cards they could match up. As they completed this they were encouraged to look for any tricks to identifying the symbols (e.g. a box usually signifies some type of resistor, a diagonal arrow implies the component is variable in some way etc). They were encouraged to use any tricks/patterns to help them remember the different symbols.

The last question was challenging as the students had not yet covered this symbol explicitly. It would rely on students tying together a lot of the knowledge gained within the lesson thus far, and then relying on a little background familiarity of the word LED used in every day life.

This image shows feedback from a lesson observer referring to the AFL whiteboard quiz plenary of this lesson.

This confirms using a second perspective that the whiteboard quiz was well received, and that for this aspect the AFL showed great retention of the lesson content.

Excellent plenary. Great participation and good knowledge shown by students.

Love the LED challenge. Worth starting with this.

From discussions with the observer (this class's regular teacher) it was decided that some aspects from this lesson needed to be reiterated in the following lesson.

Unfortunately the students were not quite able to figure out the component name from the last diagram. The answer was revealed to the students at the end of the lesson, though the observer suggested starting with this challenge to start the next lesson.

This section of the lesson plan demonstrates the teacher's initial evaluation of the their students' learning immediately after the lesson.

Circulation and conversations with students during their main task allowed further investigation into which aspects in particular appeared to be causing issues.

Evaluation of Pupil Learning	
Evidence of Learning (including attitude to learning over time)	Majority of students could identify the circuit symbols correctly in the whiteboard quiz, at the beginning they struggled with basic components. Lesson was pitched too hard, students obviously frustrated with not understanding V, I, R. Rather than disrupt, students were more likely to attempt to struggle through, shows excellent attitude towards their own learning.
Next Steps for Progress	Rehash through voltage, current, and resistance definitions. Use simpler analogy to explain, and show model answers.

This showed the teacher that every student had at least made some definite amount of progress over the course of the lesson. The whiteboard quiz allowed to check the understanding and progress of every single student individually without slowing the pace of the lesson.

The analogy used in this lesson was how voltage, current and resistance relate to the flow of water in pipes. Although this helped conceptualise these terms for some, it was clear others just found it confusing. It was decided that in the following lesson a student moving around the room would be a more accessible way of explaining the key concepts.

Initial questioning revealed there was an issue with the difficulty level of the content at the beginning of the lesson, so some aspects were adapted with the intent to revisit the rest of the content again another lesson.

Following the lesson just outlined, another lesson on the same topic was delivered to the same class, this time including some practical elements. After concretising any uncertainties from last lesson, the objective of the lesson was focused on giving students some experience with basic electrical equipment as well as investigating Ohm's law.

The focus of this lesson from the perspective of the student teacher was developing questioning technique as an effective AFL strategy. This excerpt from the lesson observers written feedback highlights aspects of the questioning.

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It was ensured that during questioning ideas were still developed and challenged. Not only can the teacher gauge understanding, but the questioning can be made meaningful with the introduction of new ideas in a discussion format.

Probing questions were used to 'keep the momentum going' on correct answers, allowing a higher level of confidence when approaching a tough question.

10082-Tuesday 3rd Lesson 2
Do now task - clear and useful activity
Students fully engaged with it.
Again, lovely warm responses to pupils' answers. You encouraged them to extend their answers and stretched their understanding.
Good to use "No hands up" as a strategy and then probe them.
When Student responded with "I don't know", you asked to alternative questions to try to get her to answer.
"Someone other than you 3" - I liked the positive way you dealt with the boys who are frequent contributors.

More enthusiastic engagement from students is likely a symptom from pitching the lesson at the right difficulty level, thanks to changes made guided by the evaluation of the previous lesson.

"No hands up" allows for a random and fair sample of questions spread across the ability range of the class to try and get a clear understanding of 'where they are at' as a whole.

For 'hands up' it can be seen as quite important to be transparent with intentions when wanting to 'ignore' frequent contributors. Although from the teachers perspective they already know certain students are capable of answering questions, it is important to not alienate these high attaining students by simply ignoring them. Ideally they would be given the chance to contribute through some challenging questions, and then simply explain it is important to try and hear from everyone in the class, and not just the same people.

This evaluation was written following the lesson as outlined above.

Evaluation of Pupil Learning	
Evidence of Learning (including attitude to learning over time)	Genuine interest in the practical aspect of the lesson shows the pupils are keen to further their understanding. Correctly identified problems in the circuit diagram examples, and correct terms used to describe V, I, and R when questioning random students shows improvement from last lesson.
Next Steps for Progress	To move on to learning Ohm's law, and using $V=IR$ to calculate some values of V, I, and R in practise for the types of exam questions they will face.

It looks as if the opportunity to learn through practical work improved attitude, or that the more accessible content increased confidence in the students.

It is identified that the questioning portion of the lesson not only went well, but identified that the changes made to enhance learning were somewhat effective.

The next steps for progress offer up different challenges. Assessment is much more linear as the upcoming work is very calculation heavy, but identifying what is slowing learning can be much more difficult.

The next example of AFL comes from a top set year 9 science lesson. During the lesson students had learned about how transects are used, some new key biology terms, and practise in drawing a kite diagram. For the plenary of the lesson a simple true or false quiz was employed to assess the learning of the class as a whole to determine if it was appropriate to move on to the next topic.

These two slides are a sample of the kinds of questions asked in the true or false quiz that formed the plenary of the described lesson. Students participated in the quiz using their school planners; the back pages had a green card with 'True' written on it, and a red card with 'False'. Once it was time to reveal their answers students would hold up the planner with the corresponding page.

True or False

The slides were animated, with statements appearing, then changing colour once it was time for the answer to be revealed.

Amount of light available is an abiotic factor

This is an example of the type of question testing retention and understanding of some of the key terms introduced in this lesson. The number of students answering these questions correctly may influence the time spent reviewing these terms next lesson.

True or False

Lichen grows better on the north facing side of trees

This is an example of a question that relied on students finishing the main task (the kite diagrams). Having this question in the quiz gave opportunity of a small class discussion, allowing students who did not complete their work still achieve an understand of the conclusions drawn in the experiment.

The teacher could have simply read aloud the questions they wanted students to answer true or false to. This method would have allowed more flexibility and adaptability of questions. However, an animated PowerPoint was used under the assumption that students would more likely engage with content they perceive to have more thought and effort put in. If the plenary quiz seems ad hoc and unplanned, then subconsciously or not, students may not bother to participate in their full capacity.

A large portion of the evaluation comes from general interaction with students (during questioning, discussion and circulation).

This section shows the initial evaluation of pupil learning as a consequence of the lesson outlined above.

Evaluation of Pupil Learning	
Evidence of Learning (including attitude to learning over time))	Excellent prior knowledge of quadrats. A few students were confused about what lichen is, but were able to produce a basic plan for how to conduct an investigation using a transect with some encouragement (explanation of task was <u>maybe too ambiguous</u>). Great responses to questioning about interpreting a kite graph. When starting to produce their own kite graphs, questions directed at teacher indicated a complete lack of understanding of how to draw a graph, so steps were taken to draw an example on the board and specifically instruct the number of squares to use etc. But when circulating around class, almost all students were completing the graph perfectly without issue, so perhaps there was some sort of 'mental block' or doubt regarding drawing a graph.
Next Steps for Progress	Confidence in drawing graphs needs building through practise. Some work of reducing the fear of 'getting something wrong' or having a messy first attempt would go a long way with building the confidence of this very able class. More work on interpreting kite graphs and drawing out some biology theory that was just touched upon (zonation, abiotic factors etc) would be an appropriate next step.

Questions and queries from students regarding their kite graphs initially had the teacher worried that an insufficient explanation of the task had been provided, and that this class's graphical skills had been vastly over estimated. But upon reflection after students had completed the task the teacher was more inclined to believe there to be more of a confidence issue rather than an ability issue.

For open questions, a few minutes were given for students to have some collaborative discussions with the people near them before asking for answers. This method works particularly well with this very able class. The responses given under these circumstances are often well thought through ideas with little elaboration or probing questions necessary.

As presumed, more work was needed on the new work was needed on the new concepts introduced, but this work may take a more student led form as this class already clearly had gotten to grips with the basics. This class performs well with research and discussion based activities in particular.

Cross-Curriculum Responsibilities

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The first example demonstrating cross-curriculum responsibilities focuses on both literacy skills, and digital competency. The activity was designed for a year 7 science class and spanned a number of lessons. The task given to students was to produce a written report containing information regarding the different types of energy and a brief history of its study. Students were directed to researching information for their reports using Chromebooks.

Students were shown this exemplar piece to help them conceptualise their own report. Literacy skills proliferate heavily through this entire task, not only with writing, but also reading and understanding texts to determine what information is relevant for the report. Digital competency comes into the piece of work through researching through the internet and also through word processing their report if the child chooses so.

Students were encouraged to create their introduction as well as the title of their report as one of their last steps.

Students were not given paper or digital copies of this report for fear of encouraging them to attempt to copy. Their only access to it was through the class projector.

WORKING OUT WITH ENERGY

To work out energy it is important to know exactly what energy is and how it can present itself in a variety of different forms. This report aims to define what energy is and introduce the different forms it can take with examples to help illustrate.

Energy can be defined as the ability to do work. When energy is transferred from one form to another work is done. The amount of energy transferred or the amount of work done can be measured in joules (J). This unit is named after James Prescott Joule an English scientist who lived from 1818 to 1889. An important energy law is that energy has always existed; it cannot be created or destroyed.

There are **nine** different forms of energy and there are many examples of energy changing from one form to another. Some forms of energy are quite obvious, other forms are more difficult to observe or recognise.

Light is a form of energy, our main source of light is the Sun and this is also the main source of energy here on planet Earth. Other examples of light energy producers are lamps, L.E.D.s and fire.

Heat or thermal energy is another form of energy and again we receive a lot of energy in this form from the Sun. A kettle, toaster and gas boiler are examples from my house that give out heat energy.

Two other quite obvious forms of energy are **sound** and **movement**. Movement energy is also called **kinetic** energy. Speakers in your TV, radio or phone give out sound energy as does your voice. Any moving object has kinetic energy such as a running athlete or a speeding car.

There are three forms of energy that are a form of stored energy. These types are often called potential energy.

Firstly, there is **chemical potential** energy. This is the form of energy that is stored in batteries, food and fuel. You have to do something to release and transfer this type of energy such as digest your food, connect the batteries or burn the fuel.

Secondly, there is **gravitational potential** energy. This is energy an object has due to its position or height. When an object is raised up it stores **gravitational potential** energy. When it is moved back down it transfers into another form, usually kinetic. For example if you climb a mountain, at the top you gain **gravitational potential** energy. Then, when you fall back down the mountain, this **gravitational potential** energy transfers into kinetic energy.

Thirdly, there is a form of energy called **elastic potential** energy. This is the energy stored by an object when it is squashed or stretched. When it returns to its original shape it releases this stored energy. Everyday examples are squashed springs or stretched rubber bands.

The final two forms of energy are more difficult to observe. **Electrical** energy is the energy that electrical charges have. An example is a circuit which has tiny charges called electrons flowing through wires to transfer electrical energy. These electrons are impossible to see although you can see the effect of nature's moving electrical charges when you see a lightning strike.

The last of the nine forms of energy is **nuclear** energy. This energy is locked up in the nucleus or centre of an atom. Again you cannot see this energy we cannot even see atoms with our eyes. This energy can be released when a nucleus is split. This is used in nuclear power stations to provide some of our country's energy. Homer Simpson works in a nuclear power station in Springfield.

Sources used:
www.wikipedia
www.energyquest.ca.gov

Students were encouraged to include images as they can be used to help express and understand concepts.

Students were encouraged to structure their work into separate paragraphs for each form of energy. This would help keep the flow of the piece, and encourages a structured and methodical approach to writing.

Students were expected to make a reference list of any books or websites used. This is likely the first time they have had to create a reference list, so detailed and exact references were not expected. However, starting students referencing early on in their school life may have a positive impact on their writing in future.

To make this task more accessible with the less literacy able students, a scaffolded version of the report was made available, two pages of which can be seen here. Students were given the option of either filling in these pages by answering the questions as their final report, or just using this to create some notes which they would then produce their final report from.

Answering these questions in full sentences should produce a report somewhat similar to the example above. Breaking the report down into a series of repetitive questions is just enough to stop students getting lost within the enormity of their task, whilst not 'dumbing down' the task. Students that may normally excel in their science lessons could be the ones that struggle most with the literacy aspect of this task.

Report Title: _____

Answer the questions in full sentences to help guide your report.

Introduction
What is this report about?

What are your aims for this report?

Energy
What is Energy?

What is the conservation of energy principle?

What unit do we measure energy in, and where did the unit come from?

Light
What is light?

What are some examples and uses of light?

Heat energy
What is heat?

What are some examples and uses of heat?

Sound energy
What is sound?

What are some examples and uses of sound?

Unfortunately a large number of capable students were tempted to use this more heavily scaffolded hand written method as it was perceived as less work overall. Differentiating literacy tasks is something that some consider fairly difficult to balance correctly. Giving choice of different tasks can lead to the described scenario, where students aren't pushing themselves to the best of their ability. However, not giving more scaffolded approaches can lead to some students just becoming overwhelmed with a task like this.

For the dual purposes of providing a back-up in the event of technical failure, and for less digitally competent students information sheets like these were made available. These information packs contained all of the relevant information, and more. Students would still need to use their research skills to look up information, interpret it, and summarise it. The information was compiled from four different sources with references for the students to use.

Heat or thermal energy

Thermal energy (also called **heat energy**) is produced when a **rise in temperature** causes **atoms and molecules to move faster** and collide with each other.

The energy that comes from the temperature of the heated substance is called thermal energy.

What is thermal energy?

Thermal energy is energy that comes from a substance whose molecules and atoms are vibrating faster due to a rise in temperature.

How is thermal energy produced?

The molecules and atoms that make up matter are moving all the time. When a substance heats up, the rise in temperature makes these particles move faster and bump into each other.

Thermal energy is the energy that comes from the heated-up substance. The hotter the substance, the more its particles move, and the higher its thermal energy.

What are some examples of thermal energy?

Here are some everyday examples of thermal energy that you'll be familiar with:

Chemical energy

Chemical energy is energy **stored in the bonds of chemical compounds**, like atoms and molecules. This energy is released when a **chemical reaction** takes place.

Usually, once chemical energy has been released from a substance, that substance is **transformed** into a completely new substance.

What is chemical energy?

Chemical energy is stored in the bonds that **connect atoms with other atoms** and molecules with other molecules. Because chemical energy is stored, it is a form of potential energy.

When a **chemical reaction** takes place, the stored chemical energy is released.

Heat is often produced as a by-product of a chemical reaction – this is called an **exothermic reaction**.

How is chemical energy used?

Chemical energy is the most widely used type of energy in the world, as it is crucial to the existence of humans and the natural world.

Chemical energy in food

The food we eat contains stored chemical energy. As the bonds between the atoms in food loosen or break, a chemical reaction takes place, and new compounds are created.

The energy produced from this reaction keeps us warm, helps us move, and allows us to grow. Different foods store different amounts of energy.

Students still need to discern which elements they want to use for their report. Many students used these information packs to cover any content they were missing.

Examples of images to reinforce the idea that students can use illustration to help communicate their ideas.

Examples of images to reinforce the idea that students can use illustration to help communicate their ideas.

What are some examples of thermal energy?



Here are some everyday examples of thermal energy that you'll be familiar with:

- The warmth from the sun
- Baking in an oven
- The heat from a heater

Reference: <https://www.solarschools.net/knowledge-bank/energy/types/thermal>

of humans and the natural world.

Chemical energy in food

The food we eat contains stored chemical energy. As the bonds between the atoms in food loosen or break, a chemical reaction takes place, and new compounds are created.

The energy produced from this reaction keeps us warm, helps us move, and allows us to grow. Different foods store different amounts of energy.

Chemical energy in wood

Dry wood contains stored chemical energy. When you burn that wood in a fireplace, chemical energy is released and converted into thermal energy (heat) and light energy.

And what about the wood? Following the chemical reaction, it's now turned into a new substance – ash.



As part of a starter activity students were asked to self-mark their report after just one lesson. No students had gotten to the stage of near completion at this stage, the self-marking task was set this early for two reasons. Firstly, to show the students what criteria their reports will be marked against. And secondly, to allow students to set themselves some targets on what progress they would like to make on their report over the course of the current lesson.

Formative Assessment checklist for draft Energy Report

	Excellent	Good	Improvement needed	Comments
Use of capital letters, full stops and sentences.				
Spelling				
The structure of your report. How well it reads.				
Your explanation of Energy.				
Your description of energy forms. i.e. all nine				
Use of examples in your descriptions.				
Use of images in your report.				
Resources used and stated.				

The marking criteria was fabricated by the school and clearly has a heavy focus on literacy skills, showing the school's commitment to ensuring cross curriculum responsibilities are met.

Students were just told to tick one of the first three boxes for each marking criteria and not to worry about the comment box.

Do Now: Set yourself two targets for your draft report so far.

- 1)
- 2)

Students were asked to come up with at least two meaningful targets for their report so far. Targets needed to be specific and ambitious.

The next example of cross-curriculum responsibilities focuses on numeracy skills. The example is an exercise completed with the same year 7 class as outlined in the previous example. The energy topic gives ample opportunity to develop numeracy skills, and in this occurrence a focus on percentage and decimal efficiency. The lesson consisted initially of explaining an example of the kind of calculations that students would be completing shortly.

This is worksheet given to students to complete as the main body of the lesson. All students were expected to work through the first question with help offered by the teacher through circulation. Students were encouraged to help one another out on sections they were 'stuck' on.

Energy Efficiency Worksheet

You may find the following equation helpful for your calculations:

$$\text{Energy Efficiency} = \frac{\text{Useful energy transferred (output)}}{\text{Total energy supplied to device (input)}}$$

The only equation needed for all calculations on this sheet.

1) Fill in the gaps on the following table:

	Energy input	Energy output	Efficiency (as a number)	Percentage Efficiency
Electric Drill	160W	Kinetic 90W Sound 30W Heat 40W		
Hair drier	180W	Heat 160W Kinetic ___W Sound 10W	0.94	
Mobile phone charger	___W	0.8W Electrical 0.2W Heat		
Electric hob	1500W	Heat 1300W Light 150W Sound ___W		
Kettle	2.5kW	Heat 2.2kW		

Some sections rely on recalling a principle heavily covered in previous lessons (energy conservation).

Knowledge of 1kW = 1000W is helpful, but not strictly necessary. Introducing the use of different units from context before having to

Electric hob	1500W	Light 150W Sound ___W		
Kettle	2.5kW	Heat 2.2kW Sound 0.3kW		

Knowledge of 1kW = 1000W is helpful, but not strictly necessary. Introducing the use of different units from context before having to consider them in calculations can be helpful with confidence.

The final question still requires calculations, but is more open ended. It allowed different abilities to investigate the question at different depths.

- 2) A 60-Watt halogen lamp produces 12W of light. An LED with an input of 10W produces only 8W of light. Explain which light source is more energy efficient (use calculations to help justify your answer).

This evaluation was completed after the lesson outlined above. The decision was made to review the same content of the previous lesson using a more differentiated main task sheet, as well as going through multiple examples identical to the first few questions up on the board.

Evaluation of Pupil Learning	
Evidence of Learning (including attitude to learning over time)	'Do now' tasks mostly completed to acceptable standard. Even though students struggled through main task, they stayed on task and showed resilience in attempting to complete the work. Hands up indication showed all students could recall some energy transfers and relate them to energy conservation; Some students understood how to calculate the efficiency of household appliances as both a decimal and as a percentage; and only a few could numerically determine which products were most efficient.
Next Steps for Progress	- Rehash calculations with a more differentiated worksheet. - Go through examples with class - Let them just do calculations with not many other concepts at first (conservation of energy, useful/waste etc)

A quick 'traffic light' assessment of learning objectives at the end of the lesson showed that students understood the content in regards to energy transfers, but most students struggled with calculating efficiency.

When assessing the learning that took place in the lesson in question, it became apparent afterwards based on students' class work that more students were struggling with the content than initially anticipated during the lesson.

It was possible students were capable of calculating simple efficiency calculations, but were getting confused with other aspects being added. A worksheet with a single focus was needed to advance the class.

This sheet is the result of reflection of the evaluation of pupil learning. Instead of working in units of power, students were required to work in units of energy. Not only did the teacher go through examples on the board, but there is an example on the sheet. The sheet is much more differentiated, and allows students to just focus on their numeracy skills for the first two sections.

Energy Efficiency Worksheet

$$\text{Energy Efficiency} = \frac{\text{Useful energy transferred (output)}}{\text{Total energy supplied to device (input)}}$$

Everyone must complete 'medium' and one other section. (Do any workings in your book).

Setting the expectation for students to just complete two sections enables students to still be able to get all of their work attempted correct, in part negating the fear of getting the wrong answer.

Mild

Energy Input	Useful Energy Output	Efficiency	Percentage Efficiency
100J	50J	$50 \div 100 = 0.5$	$0.5 \times 100\% = 50\%$
10J	1J		
60J	20J		
18J	6J		

Medium

Energy Input	Useful Energy Output	Efficiency	Percentage Efficiency
19J	4J		
100J	99J		
112J	12J		
1J	0.2J		
15J	0.3J		

Some harder questions in the medium section require a calculator and rounding.

Hot!

Energy Input	Useful Energy Output	Efficiency	Percentage Efficiency
1kJ	100J		
20J			20%
10kJ		0.01	
	16J	0.5	
	2kJ		0.1%
10MJ	1J		
2MJ	2kJ		
1440J	0.8kJ		

On the board there were some hints as to what MJ and kJ are equivalent to, as these values are required to calculate some of the values.

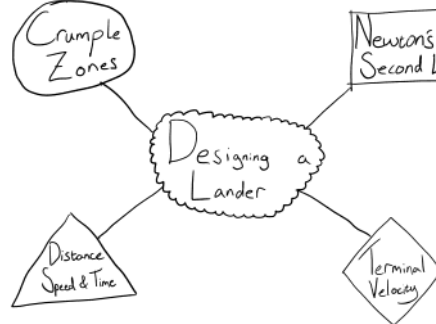
To stretch and challenge students, some calculations had to be done in reverse order to others.

Employing a blend of approaches including direct teaching.

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The first example demonstrating a blend of approaches is very student led, it is from a year 8 science lesson. Students had spent many lessons previously learning about forces, they then spent a number of lessons designing, building and testing catapults. This lesson sits just before the class moves on to designing and building a lander in groups. Its main objective is to allow students to revise all they have learned from the beginning of the year to allow them to design and build a successful lander.

After being shown a video of a lander, students were tasked with completing a mind map of all the relevant topics they have completed. Students could use the template as seen below to start them off, or they could make their own from scratch.



The rough, hand written style hopefully encourages students to get as many ideas down as they can, and not get too 'hung up' on neatness

Students were encouraged to gather information from their exercise books for their individual mind maps at first, and then use the A3 information sheets (one of which can be seen below) to fill in any gaps they have.

FORCES

Force and Movement
Forces are nearly always **Pushes and Pulls**.

- Forces can't be seen, but the effects of a force can be seen.
- They are measured in newtons — N.
- They usually act in pairs.
- They always act in a certain direction.
- A newton meter is used to measure forces.
- We show their direction and size using arrows.

Forces can make objects do five things:

- Speed up — like kicking a football.
- Slow down — like drag or air resistance.
- Change Direction — like hitting a ball with a bat.
- Turn — like turning a spinner.
- Change Shape — like stretching, twisting, compressing, bending.

Speed is how fast you're going

- Speed is simply how you've travelled in a certain line.
- The formula triangle can be used to work out speed.

Remember **SIDOT**: Speed is distance over time.

There are 3 common units for speed:

- metres per second — m/s
- miles per hour — m.p.h.
- kilometres per hour — km/h

$$\begin{array}{c} D \\ \hline S \quad T \\ \hline \end{array}$$

D = Distance
S = Speed
T = Time

Learn these two important statements:

Balanced forces cause no change in movement. This means if the object isn't moving it will stay not moving; if it's moving at a constant speed, it will stay moving at that constant speed.

Unbalanced forces change the speed and/or direction of moving objects.

RESULTANT FORCE — this is the overall force acting on an object. If forces are in the same direction, we add them. If they are in the opposite direction, we subtract. If the forces are balanced the resultant force is 0.

Friction
Tries to stop objects sliding past each other.

The good points of friction:	The bad points of friction:
1) It allows you to start and stop	1) It slows things down
2) It allows tyres to grip the road surface	2) It wastes energy
3) It helps brakes to work	3) It causes things to heat up
4) All the nuts and bolts to hold things together	4) It causes things to wear away

KEY WORDS:

Force	Newton	Balanced	Unbalanced
Acceleration (speed up)	Deceleration (slow down)	Terminal speed	Resultant force
Crumple zones	Impact force	Air resistance	Drag
	Mass	Weight	

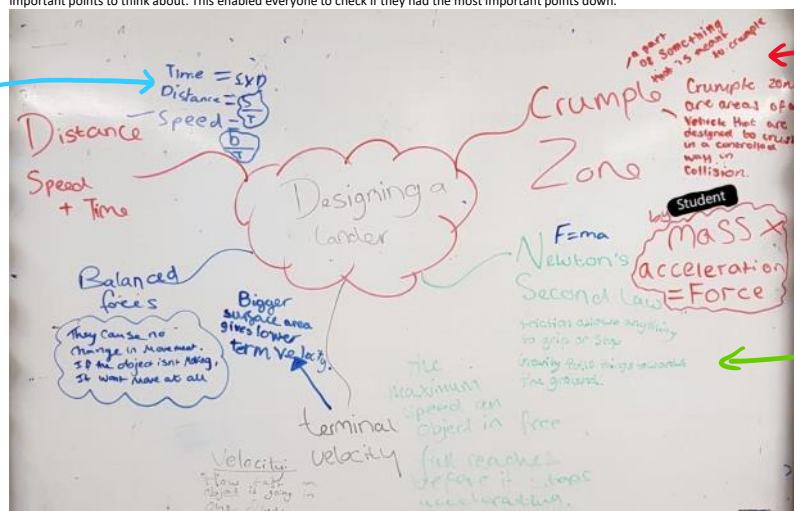
These A3 sheets were given out amongst tables of around 5 students to try and encourage collaborative work.

These key words give students an idea of what is important to include on their mind maps if they are unsure

Simple cartoon diagrams can help with conceptualisation, very useful when there are many different ideas being used simultaneously

Students were asked to contribute to a class wide mind map on the board, just highlighting what the students thought were the most important points to think about. This enabled everyone to check if they had the most important points down.

In a scenario such as this, it is easy for incorrect information to make it up onto the board unnoticed by the teacher. This may lead to students copying down incorrect answers. The teacher should be more diligent to catch mistakes when doing activities such as this.



This method seemed both effective and time efficient when compared with going through all possible points students had come up with. It also meant there were no 'best' ideas, students were allowed to write down what they thought the most important points were.

This method really engages enthusiastic students, and gives them a large voice in the class. The downside is that lessons like this enabled quiet, disengaged students to 'fly under the radar' and avoid getting involved with the learning.

The next example employs an inference grid to perfectly bridge together two sections of the syllabus. The lesson was a top set year 9 biology lesson. The student teacher in question was only teaching students for the first portion of the lesson, and the regular class teacher was taking over for the remainder. The students had just finished a portion of work on intensive farming, and were moving on to studying some of the effects fertilizer can have on the ecosystem.

The teaching notes on the school's system has an example of a dead fish in an algae filled lake, and require students to infer what caused the death of the fish.

Teaching notes for the eutrophication topic

Lesson 1 – research task so **Chromebooks will be required.** Pupils discuss the image starter and infer what is happening to cause the death of fish in the lake.

Pupils can use the template for the research task to think about key questions to guide their research.

The task can be completed for homework.

4Ps context = A2, A5 and A8

This class works particularly well with both discussion and research tasks, so most of the students should excel with this kind of task.

Refers to Donaldson's four purposes.

This is the research task students are moving on to after discussing the dead fish.

+ Research task
Think of four questions related to the photo that you want to research and then prepare and complete the table

Key questions that I need to research	What did I find out and learn?	Source of the information

Students need to develop some questions they want to research. Having relevant and meaningful questions to begin with is critically important to the ability to complete the task.

Students are required to reference the sources of their research, making the research aspect of the task that much more realistic and meaningful.

The method devised to enable students to develop meaningful research questions relating to the topics at hand is to make use of an inference grid. Inference grids are normally used in the humanities, but can also be used in science to great success. Students were given a brief reminder of how to use the grid as they have used them before in other subject areas. Once students had time to fill a few branches to completion and result in a number of questions, a class discussion was opened up to allow students to share the questions they were left with to allow students to think about what research questions they want to choose.

What information am I missing/ What questions am I left with?

What can I infer (guess) from these observations?

What can I see directly in the image?



Using an inference grid seems the most natural and effective method for students to develop questions based on a single image.

Structuring a resource like this encourages very methodical and critical thinking in students. Highlighting that inferring is similar to guessing, students are likely to come up with multiple explanations.

This is the original image given in the teaching guidance. It is important students had colour copies of the image. The two main branches students should start with are the dead fish, and the large patch of green matter.

The next example of showing a blend of teaching methods highlights a direct teaching method. This was a stand-alone lesson for a year 7 class. The students had yet to use Bunsen burners in any way within their education thus far. The main objectives for the lesson were for students to learn how a Bunsen burner works, what are the names for its parts, and learn how to safely operate it. The lesson was structured with the first portion being very teacher led using a PowerPoint with students filling in prepared worksheets. The main portion of the lesson was the practice element where students would practise lighting the burners. The final portion of the lesson was pair discussion intermingled with random questioning, followed by students filling in a simple risk assessment for this lesson's activities, finally followed by each student being presented with a 'Bunsen burner licence' they could stick in their books.

This is most of the PowerPoint slides as shown to the class.



A 'Do Now' task enables a teacher to greet students at the door as they come into the lesson, as well as take the register as students are busy with an immediate task to start.

Critical reflection

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Three important pedagogical principles will be discussed and compared with one's current teaching experience and development so far. References to annotated examples will be explicit to demonstrate current practise, and what is needed to progress as an educator. Focus will be placed on both planning and executions of lessons in particular. Professional Teaching Experience offers the opportunity for student teachers to explore a variety of teaching methods and resources whilst becoming comfortable with the school environment. Many believe now is an exciting time to be an education practitioner in Wales. The new curriculum offers student teachers an opportunity to explore and traverse the many different teaching methods now more than ever. The amount of literature available which is designed to aid, and guide teachers' practise is vast and ever growing. So now is an exhilarating time to be a student teacher and Professional Teacher Experience is arguably one of the best methods to flourish as an emerging educator.

In his report Donaldson outlines twelve pedagogical principles, three of which are: Good teaching and learning means employing assessment for learning principles; Good teaching and learning regularly reinforces Cross-curriculum Responsibilities, including literacy, numeracy and digital competence, and provides opportunities to practise them; Good teaching and learning means employing a blend of approaches including direct teaching (Donaldson, 2015, Pg 64). In his report Professor Donaldson explicitly refrains from recommending certain teaching practises, and instead highlights these twelve principles of good pedagogy.

'Assessment for learning' has become synonymous with the term 'formative assesment' for many practitioners, but some believe there lies an important distinction between the two (Black, 2007, Pg 122). It is highlighted that formative assesment could include both formal, and informal assesment methods. Assessment for learning methods focus on enhancing teaching and learning often through close questioning methods (Black, 2007, Pg 90). Feedback generated is used to further the learning of individuals.

It seems that one very significant aspect of AfL techniques relies on questioning, but teachers questioning students is not a new development in pedagogy. What is new, or at least concentrated on more recently is the idea that questioning can be used in a plethora of different ways with as many different results. Many methods involve selecting a spread of students or even random students as opposed to students volunteering answers with a raised hand, one of the draws to this is that educators are able to assess and informally extrapolate the current ability of a spread, or random sample of students to the whole class. A 'good' question can be considered one which promotes discussion, and with which every student might have an answer (Welsh Assembly Government, 2010, Pg 25). One simple way in which to improve questioning skills is to increase the thinking time given to students to around three seconds. This has been achieved along with other subtleties to improve questioning, such as tactful probing, and warm positive responses, as seen in example two of the AfL section of annotated examples. This example shows a 'snapshot' of the concerted effort made to improving questioning skills in regard to formative assessment. Within this area of development, the next aspect to focus on in order to improve as an educator is to question in a natural manor which encourages discussion between students. Bouncing questions around a class like this is an ambitious goal, so a more manageable improvement for the short term is to follow up probing questions from one student to another in order to gain a different opinion on subject matter where appropriate.

Another frequently used AfL technique is the 'class quiz'. These often take the form of a lesson plenary and have the function of informing the teacher of the progress of the whole class in a time efficient way. Additionally, these exercises have the benefit of acting as an active recall practise and to passively inform students of their own progress within a lesson. Some basic class quizzing can be seen in the annotated examples, specifically a whiteboard quiz and a true or false quiz. Whilst both were fairly effective with informing the teacher to the progress of the class, the whiteboard quiz seemed more worthwhile as an activity, as it more effectively served as an engaging way of testing

students' knowledge. Discussions as to what the correct answer was at each reveal seemed more well placed and natural, and added to the flow of the activity. To improve the preparation and execution of these kinds of AfL plenaries, and to make progress as an educator, the teacher must be more imaginative and explore more fun and engaging quizzes to use for their AfL purposes. Some examples of which can be found in Brown's Secondary Starters and Plenaries (Brown, 2012), specifically under section 4: Game show. A more engaging, meaningful, and unique quiz such as these allow for students to be able to both enjoy the plenary activity of a lesson, and respect the task as a non-repetitive, useful exercise.

Cross-curriculum Responsibilities refer to literacy, numeracy and digital competence. Donaldson identifies that these skills are essential to success in almost all learning areas (Donaldson, 2015, Pg 39). Within the subject of science, literacy is not just essential for being able to explain and prove understanding of concepts, but also to understand said concepts in the first place. Higher up in science education a student's literacy can be one of the limiting factors to the accessibility to understanding scientific papers. Teaching subject specific vocabulary has a significant effect on literacy skills of students (Kirsten, 2019, Pg 377). Students are able to simultaneously build the tools necessary to excel in not only the specific subject, but also to a lesser degree their other subjects. Having multiple points of reference allows for much more depth of understanding.

The annotated example of a literacy-rich task chosen was a written report about the different forms of energy. Students were shown an exemplar report, as well as being talked through what made it a good example. This along with the fact that students were given a copy of the mark scheme their report would be marked against enabled students to understand the success criteria for the written report. For students early on in their school life, knowing what the expected standard of work is a simple but possibly effective tool for improving their writing. Students were encouraged to include illustrations, images and cartoons as it may help students consolidate their understanding of certain concepts (Keogh 1999). To make this task more accessible with the less literacy able students, a scaffolded version of the report was made available. This type of activity is often seen as 'self-differentiating' and students with different ability levels would engage with the content at different depths. Some clear improvements to be made for the planning and execution of this series of work would most definitely involve structuring students' planning time. Also, a draft version of the report submitted for peer feedback would greatly improve students' work before final submission. A literacy rich technique that has been especially useful for certain topics is the use of morphology to explain the meaning of key terms in a memorable way. Continued development of this strategy seems integral to progressing as a science teacher.

Digital competence is becoming an increasingly important aspect of students' education. The ability to use modern technology is an expected trait for today's workplace (Donaldson, 2015, Pg 41). Educational professionals should be focusing on teaching general digital skills and transferability. The annotated example for Cross-curriculum digital competence shares its role with the aforementioned energy report. Researching valid and relevant information is a skill used in almost all disciplines, and played a significant role in the creation of a successful energy report. Even at this early stage in the students education (year seven) students were encouraged to create some form of reference list for their report. During marking of the finished reports however, it became very apparent that some guidance on how to reference should have been prioritised. Some examples of students referencing was as brief as "Google" or "A book from my house". Showing an example of a new concept simply isn't enough to expect replicability. Students were also given the opportunity to word process their report, a skill that is arguably one of the most important digital skill for the average student. A direct and immediate take-away from running this set of lessons was the naivety that all students would be at roughly the same stage when using digital technologies. In-fact students had very drastically different abilities when using computers, and some differentiation strategies regarding digital competency should be planned in future.

Numeracy skills must be reinforced in a multitude of contexts in order for students to learn the skills needed for independent living and work (Donaldson, 2015, Pg 40). Developing numeracy skills in science often provokes a 'standoff' disposition from some students whom claim that they 'can't do maths' (Quinnell 2013). Some educators believe that it is essential that students no longer see numeracy tasks as optional aspects within science. Integrating numeracy tasks within aspects of all sections of Donaldson's new curriculum may offer a compatible solution to Quinnell's. In the

annotated examples there is an example of a numeracy rich worksheet that integrated both the recent lessons on energy conservation with the new concept of energy efficiency calculations. This however proved too much to handle for the year seven students as explained in the annotations. So the process of evaluation, reflection, and creation of a new worksheet is visible. If one is to progress as a science educator there is a great need to be able to assess the appropriate difficulty of numeracy rich tasks. Simply having students repeating similar mathematical calculations without them having to worry about 'the science' aspect made the difference and allowed the class to progress. More experience with integrating numeracy skills naturally into lessons is needed, some work with year nine of their kite graphing skills helped but is an area in need of much improvement.

It is important to employ a blend of teaching approaches for two main reasons, firstly, certain topics may 'fit better' with certain topics of content, and secondly, certain students may respond better to different methods. Approaching with a blend of approaches offers a holistic way in which to educate. Direct teaching is viewed by some as a very traditional method of teaching, and somehow 'bad' in this regard, but in the Successful futures report direct teaching is praised under the circumstance that it has clear purposes and success criteria, with modelling, practise and insightful feedback (Donaldson, 2015, Pg 40). Direct teaching is often set aside in favour of constructivist teaching, but many of these methods conflict with what methods have proved to be more successful in more recent times (Hattie, 2009).

In the annotated examples three different approaches were employed and commented on, the first being a section of class led revision. Students were directed to produce a mind map to summarise lessons from the beginning of the year that would prove useful in the upcoming scheme of work. Students were able to access the required revision materials from both their class books, and from shared A3 information sheets. Students were then directed to create a collaborative class mind map. As mentioned in the annotations some issues arose from allowing students autonomy for what they thought was most important to put on the mind map, leading to some incorrect details, however, the autonomy seemed to result in most students having a detailed mind map to use in their following design lessons. The second example that demonstrates a blended approach to teaching and learning offers a well-suited exercise bridging two sections of the school's syllabus. An inference grid was used with students, a technique often used in history lessons, but was well suited to the specifics of the lesson in this circumstance. Students seemed to respond well to the opportunity to exercise some critical thinking and discussion. The next step would be to explore any uses of similar models for example the Frayer Model. The final annotated example shows a direct teaching style method. Students responded well to the well organised and paced lesson. The classroom control given by the direct teaching method was necessary by itself if not just for the fact that safety was imperative for this inexperienced group of year seven. The level of support given to students felt about right given that there is a certain amount of fear and uncertainty that goes along with using a Bunsen burner for the first time. Moving forwards, having a dynamic lesson filled with periods of direct instruction and tasks of varying lengths seemed to work well, so it will be a method continued to be pursued in future. However, during PowerPoint dominated lessons one must be careful to not let classroom presence diminish. Either using a clicker to allow more movement from the central computer or becoming less reliant on the use of the projector for the pacing and organisation of a lesson would be worth investigating.

In summary, a running theme with what is required to progress as an educator comes down to being more imaginative and not being afraid to use teaching methods that would push one out of one's comfort zone. A more dynamic approach to literacy developing techniques would benefit students greatly, and more comfortably gaining a gauge for expected numeracy abilities would help when planning numeracy rich activities. Continued development of questioning techniques would probably result in the greatest response in overall improvement, especially when able to improvise questioning dynamically, until then rigorously planning lines of questioning will develop this strategy. The new curriculum offers a great opportunity to continue to develop, and thrive as an emerging education practitioner in Wales through the Professional Teaching Experience.

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