Exploring Davy's Notebooks Lesson

KS3/4 Curriculum links

Science programmes of study:

Working scientifically

- An example of how scientific ideas have developed historically and reflect modern developments in science.
- Informs students of the role of science in understanding the causes of and solutions to some of the challenges facing society.
    - The development of scientific thinking
        - The scope and nature of their study should be broad, coherent, practical and rigorous, so that students are inspired and challenged by the subject and its achievements.

English programmes of study:

Writing:

- Stories, scripts, poetry and other imaginative writing

KS3/4 Lesson plan

Session one: Exploring Davy's Notebooks

Time: 1 hour

Please note that while the bones of the content below is there, the material is incomplete. If you have an interest in implementing any of these components in your classroom, I'd love to work together to develop materials further (subject to my availability). Please do reach out at bymandyhuynh@gmail.com!

Lesson objective	To learn to think about science and art together and differently.
Learning outcomes	Understand the historical context and significance of Humphry Davy. Recognise the interconnectedness of arts and sciences in Davy's work. Explore the importance of keeping notebooks for scientific inquiry. Analyse and compare Davy's notebook practices with modern scientific practices. Reflect on the uniqueness of Davy's notebooks and their content.
Relevant previous knowledge	Writing. Journaling. Storytelling. Doing science experiments.
Resources and set-up required	Lesson plan Whiteboard and markers Student notebooks and writing tools

Lesson breakdown

Part 1 Introduction	20 mins	Come up with a collective definition for science/scientist, art/artist, and culture, and means to students. Introduce Davy and explain the history of the term "scientist."

		Introduce the idea of the “two cultures” of arts and sciences. There are 3 videos (~16 minutes) to watch.
Part 2 Arts +Sciences = Storytelling	13 mins	Invoke Davy's popular lectures at the Royal Institution (Ri). Ask students to reflect on what makes a good lecture. There are 2 videos (~8 minutes) to watch.
Part 3 Working Scientifically in Notebooks	10 mins	Discuss the importance of keeping notebooks when practising science. There is 1 video (~5 minutes) to watch.
Part 4 Investigating Davy’s Notebooks	20 mins	Examine Davy’s notebooks. Engage students in a **worksheet** activity, transcribing a page from Davy's notebook that includes both drawings and poems. Discuss the peculiarities of Davy's notebooks and what makes them special. There are 2 videos (~10 minutes) to watch.

KS3/4: Exploring Davy's Notebooks lesson notes

Part 1: Introduction

Key words: science/scientist art/artist culture "two cultures" challenging perceptions

Further watching:

See first published use of the word "scientist" in William Whewell's Quarterly Review article on Mary Somerville's book On the Connexion of the Physical Sciences.

To learn more about the "two cultures": Introduction: Some Significances of the Two Cultures Debate. Other essays: Interdisciplinary Science Reviews, Volume 41, Issue 2-3 (2016).

Suggested script

- Let's begin with a general discussion about science/scientist, art/artist, and culture. Those are three big terms, with non-definite meanings.
- How would you explain each term to someone younger than you, who doesn't know what they mean? Talk through each term with the person next to you. We will come back to discuss it as a class and come up with a special definition from everyone's perception here.

Discussion Questions
What's the place of science in culture?
How do you view the relationship between the arts and the sciences? A good place to start may be to reflect on your classes and how they are structured.

- Now, let me introduce Humphry Davy. Who was he and why should we care? Let's watch a fun video introducing him.
  Humphry Davy Biography: How Doing Drugs Led to Sucess & the Arc Lamp

- Today, we would call Davy a scientist. However, the word "scientist" was not coined until after Davy's life, in 1833 (Davy died in 1829). The term scientist was coined to be an

analogy to “artist” to name the group of people practising the ever-specialising fields of the sciences. So, even Davy himself would not have thought of himself as a “scientist” as we know it today.

- In fact, Davy saw connections between his “scientist” and “artist/poet” self.
- We’ll watch a video on Davy and his views on the similarities and differences between science and poetry.
    - Prof Sharon Ruston, 'Humphry Davy as a Poet and a Chemist' (FL 2.1, 3:40 mins)

Discussion Questions	**Example Answers**
Can you think of examples of when science has been creative and imaginative?	
What similarities might there be between poetry and chemistry?	Davy saw both chemistry and poetry (imagination) as having the power to transform one thing into another. Chemistry has the power to modify elements and forms, to make solids into gasses, or to reveal new elements through chemical processes. Similarly, the poetic imagination can modify and transform the world around us. (FL 2.1)

- You might notice a common (mis)conception of the “two cultures” of arts and sciences as two unrelated topics.
- However, as we see in his notebooks, Davy didn't see the arts and the sciences as two separate cultures. Instead, we see both poetry and chemical enquiry combined. For Davy, both offered important ways of exploring the mysteries of the world around him.
- Now, let’s watch a video where various experts give their answers to the two questions I posed earlier. We can discuss the answers afterwards.
    - What's the Relationship between Science, Culture, and the Arts? (FL 4.9, 4:34 mins)

Part 2: Arts + Sciences = Storytelling

Key words: storytelling lecturing metaphor science communication Royal Institution (Ri) celebrity chemist demonstration experimentation public audience

Further reading:

Read Davy's *A Discourse Introductory to a Course of Lectures (1802)*, delivered in the Royal Institution, on the 21st January 1802 (London, 1802) at this link.

Suggested script

- In 1801, aged 22, Davy was appointed Lecturer and later Professor at the Royal Institution in London. And for the next decade, he gave hugely popular chemical lectures with truly explosive demonstrations. Their success caused traffic jams outside in Albemarle Street, and it became the first one-way street in London.
- A French visitor, Louis Simon noted his lectures are frequently “figurative and poetical”. While Coleridge attended them to “enlarge my stock of metaphors.” (FL 2.2)
- And Sir Walter Scott’s son-in-law, John Gibson Lockhart, claimed, “Davy was, by nature, a poet.” So can we ask whether it’s possible to think of Davy’s science and his scientific writing as themselves poetical? (FL 2.1) Might this have been one of the reasons why Davy’s lectures were so popular?
- Let’s judge him for ourselves in the next few minutes.

- First, I’m going to pretend to be Davy and deliver a lecture as close to what he would have done. Pay attention to the language he uses. Does he deliver on his goal to “rather to incite feelings of interest concerning [chemistry], than to give minute information?”

ADVERTISEMENT.

I AM induced to publish the following discourse in consequence of the request of a part of the audience before whom it was delivered, the accuracy of whose judgment it would be presumptuous in me to question. It was not originally intended for the press. The subject is too important and sublime to be justly treated in an occasional composition; and the views I have taken were designed rather to excite feelings of interest concerning it, than to give minute information.

HUMPHRY DAVY.

26th April, 1802.

Davy's A Discourse Introductory to a Course of Lectures (1802), delivered in the Royal Institution, on the 21st January 1802 (London, 1802)

‘Science has given to [man] an acquaintance with the different relations of the parts of the external world; and more than that, it has bestowed upon him powers which may be almost called creative; which have enabled him to modify and change the beings

surrounding him, and by his experiments to interrogate nature with power, not simply as a scholar, passive and seeking only to understand her operations, but rather as a master, active with his own instruments.' (Discourse, p. 319)

'Science has done much for man, but it is capable of doing still more; its sources of improvement are not yet exhausted; the benefits that it has conferred ought to excite our hopes of its capability of conferring new benefits; and, in considering the progressiveness of our nature, we may reasonably look forwards to a state of greater cultivation and happiness than that which we at present enjoy.' (Discourse, p. 319)

'[The alchemists'] views of things have passed away, and a new science has gradually arisen. The dim and uncertain twilight of discovery, which gave to objects false or indefinite appearances, has been succeeded by the steady light of truth, which has shown the external world in its distinct forms, and in its true relations to human powers. The composition of the atmosphere, and the properties of the gases, have been ascertained; the phenomena of electricity have been developed; the lightnings have been taken from the clouds; and, lastly, a new influence has been discovered, which has enabled man to produce from combinations of dead matter effects which were formerly occasioned only by animal organs.' (Discourse, p. 321)

'The unequal division of property and of labour, the difference of rank and condition amongst mankind, are the sources of power in civilized life, its moving causes, and even its very soul: and, in considering and hoping that the human species is capable of becoming more enlightened and more happy, we can only expect that the different parts of the great whole of society should be intimately united together by means of knowledge and the useful arts; that they should act as the children of one great parent, with one determinate end, so that no power may be rendered useless, no exertions thrown away. In this view we do not look to distant ages, or amuse ourselves with brilliant, though delusive dreams, concerning the infinite improveability of man. […] We consider only a state of human progression arising out of its present condition. We look for a time that we may reasonably expect, for a bright day of which we already behold the dawn.' (Discourse, p. 323)

Read the full discourse at this link (also linked in further resources).

- Let's now watch a video to get a sense of the types of experiments Davy would've shown his audience. In this video, Dr. Peter Wothers reconstructs an experiment to demonstrate a volcano erupting using potassium, performed by Davy in the Royal Institution lecture theatre on 10 April 1812
    - Humphry Davy's Potassium Volcano
- Let's watch one more video about Davy's lectures at the Royal Institution; particularly, we will learn more about his audience. Who would attend his lectures?
    - Davy's lectures at the Royal Institution (FL 2.9, 4:45 mins)

Discussion Questions
What lectures have you been to that you have enjoyed and why were they enjoyable?
What do you think it would have been like to have been in Davy's lectures? What do you think about the kinds of language he uses?
Are you surprised that Davy's Royal Institution audience was largely female?

Part 3: Working Scientifically in Notebooks

Key words: scientific practice working chemist tradition experiments laboratory environment and research safety protocols hazards personal protective equipment (PPE)

Suggested script

- You wouldn't expect it, but scientists still keep handwritten notebooks today in the laboratory to keep track of their experiments, like Davy.
- We will now watch a video where Dr. Rachel Platel from the Chemistry Department at Lancaster University shows you what it is like to work in a modern day chemical laboratory. We will discuss some questions after the video to help you remember the information you learned.
    - Dr Rachel Platel, 'This is what we do today' (FL 1.11, 4:28 mins)

Discussion Questions	Example Answers
What are some key differences in chemistry practices between Davy's time in the 1800s and today?	There was no legislation around scientific research in the 1800s, so Davy would have been able to work exactly as he wanted. There is a lot more known now about the toxicity of chemicals, and a system of hazard classification and control measures has been developed to help researchers work safely with toxic substances, but without putting themselves or others at risk of exposure. One of the control measures is the use of Personal Protective Equipment (or PPE), i.e., a lab coat, safety spectacles, and sometimes gloves. In the 1800s, chemists had far less prior knowledge to base their research on than we have today. The behaviour of elements is dependent on their position in the periodic table, which was not published until 1869 by Mendeleev. Davy is credited with the discovery of nine elements, and his work

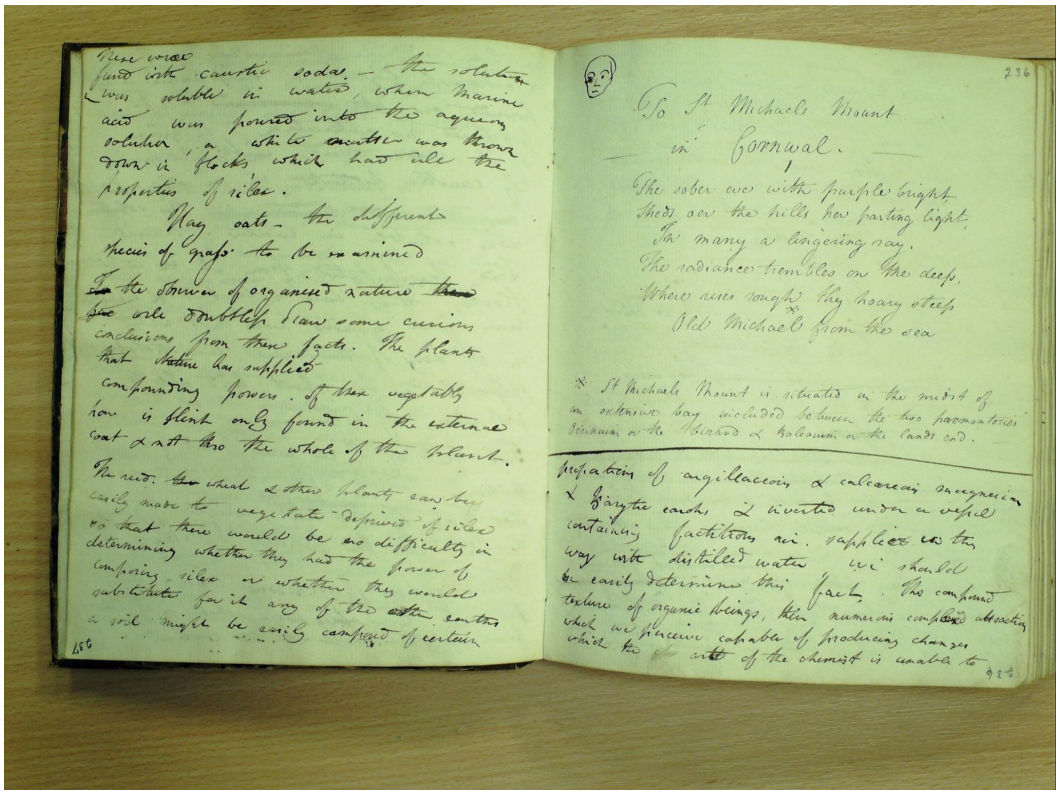
	pre-dates the periodic table as we know it today, so he was very much working in the dark. The chemistry he did was therefore of a far more fundamental nature than the chemistry we do nowadays. There are many differences between the scientific equipment at our disposal here and the instruments that Davy would have used. As chemists, we probe the nature of chemical bonds and compounds and thus understand and rationalise their behaviour. For instance, an infrared spectrometer tells us what bonds are present in a molecule by analysing their vibrations. We can often get the results in just seconds or minutes, whereas many of the techniques did not actually exist in the 1800s. Then, most materials were investigated through their behaviour with other things such as water and acids. New materials were routinely tasted to see if they had an acidic or a soapy taste.
What is one example of a scientific practice that has not changed?	Despite many technological advances that make electronic note-taking possible, still by far the most reliable method of recording progress in research is by hand using a physical laboratory notebook. This creates a permanent record of experiments done and their results, which can be made in real time in the lab and kept forever.
Why is it important to keep a notebook as a scientist?	To record your immediate thoughts and impressions. To prepare for experiments and record their outcomes. To jot down your interpretative and theoretical ideas as they come to you. To attempt to recreate your experiments and compare results.

Part 4: Investigating Davy's Notebooks

Key words: notebook writing drawing record poetry journaling thinking constructing scientific knowledge

Suggested script

- As we just learned from the last video, one of the prerequisites to undertaking successful scientific research is keeping a notebook. Most scientific notebooks have some sort of discernible order to them, recording the preparation and outcomes of experiments, perhaps jotting down interpretive and theoretical ideas. Davy's are different.
- We will now watch a video about Davy's notebooks in the Royal Institution, and find out in what ways Davy's notebooks are special. While watching, also think about how scientific knowledge is constructed by such practices as writing notes and drawing pictures in notebooks. Then, we will discuss some questions to help you remember the information you learned.
    - Davy's notebooks in the Royal Institution (FL 2.8, 4:43 mins)
- Below is a page out of Davy's notebook (displayed in the exhibition). Let's try transcribing it and observe its details.



    - The transcription of "To St Michaels Mount" poem, with chemical notes on same page:

      [Ink sketch of a face] To S[superscript]t[/superscript] Michaels Mount
      - in Cornwal.-
      The sober eve with purple bright
      Sheds o'er the hills her parting light,
      In many a lingering ray,
      The radiance trembles on the deep,
      Where rises rough thy hoary steep

Old Michael [insertion]*[/insertion] from the sea
* St Michaels Mount is situated in the midst of
an extensive bay included between the two promontories
Oerinium or the Lizard & Bolerium or the lands end
[Horizontal rule]
proportions of argillaceous & calcareous magnesium
& Barytic conch & inverted under a vessel
containing factitious air supplied in this
way with distilled water we should
be easily determined this fact. The compound
texture of organic beings, their numerous [unclear]complexed[/unclear] attraction
which we perceive capable of producing changes
which the [deletion]glo[/deletion] art of the chemist is unable to
{236}

Discussion Questions	**Example Answers**
Do you use notebooks and if so, what for? If not, why not?	
How do you like to express your thoughts? Through what means?	
Why are Davy's notebooks different from those of other men of science of this time?	Many of the notebooks contain, in addition to experimental descriptions, drafts of poems, philosophical speculations, and drawings of landscapes that occasionally have no relevance to the text, sometimes on the same page. He does not fill them in from the first page to the last. Sometimes, he would start a notebook at one end, and at some point, begin it again from the other.
What can we learn from Davy's notebooks?	Understanding these notebooks, and those of other scientific figures, tells us much about the actual hard practice of constructing scientific knowledge. A scientific paper or book usually seeks to make an argument about the natural world and does not usually reflect the processes by which that knowledge was constructed. In Davy's case, these notebooks provide that insight. But because of his individualistic, not to say idiosyncratic, note keeping practices also provides us with valuable insights into

	how he combined what might be viewed today as wildly separate practices.

Part 5: Conclusion

Conclusion:

Think back to our discussion of who you thought scientists and artists were and what they did at the beginning of this lecture. Ask yourself the same questions.

Spend a few minutes to write, draw, talk to your neighbour, or find some other creative way to express how your perception of these socially-drawn categories has changed.

For a possible homework task, encourage students to keep a simple notebook for a week, recording observations, thoughts, and ideas [see next section, “Creative Project”].

Session two: Creative Project: Curiosity Notebook Exploration (*Optional Lesson Extension*)

Time: 1 term or 6-8 weeks (adjustable to a shorter-term project)

Lesson objective	To engage KS3 students in improving their handwriting skills while nurturing their individual, unique curiosities and critical thinking skills through keeping a notebook.
Learning outcomes	Improve students’ ‘notebooking’ (putting pen to paper) skills through daily practice. Encourage curiosity and critical thinking by acknowledging and recording them down. Exercise ability to identify interdisciplinary connections between subjects. Formulate and refine research questions based on personal interests. Engage in creative expression through poetry inspired by investigative experiences. Foster a holistic understanding of various subjects and the world around them.
Relevant previous knowledge	N/A
Resources and set-up	Bound notebooks for each student (for extra fun and investment, provide materials for students to make their own notebooks)

required	Writing materials (pens, pencils, markers, etc.) Prompts and example questions (displayed or printed) Access to resources for research (library, internet, etc.)

Project breakdown

Part 1 Introduction to curiosity and Curiosity Notebooks	2 weeks	Importance of (hand)writing to think. Introduce the concept of Curiosity Notebooks and their purpose (provide minimal direction for how the notebook should be set up). Distribute or set up arts and crafts sessions to make notebooks.
Part 2 Practising and capturing curiosity	2 weeks	Assign the task of recording any questions/thoughts not directly related to school subjects for two weeks. Discuss the collected questions and encourage students to find patterns or connections among them.
Part 3 Interdisciplinary connections and creative expression	1 week	Introduce the concept of interdisciplinary learning and its benefits. Encourage students to identify connections between subjects and how knowledge in one area can inform another. Revisit Davy's poems and ask students to write a sensory-inspired poem based on their investigations, invoking their five senses and emotions.
Part 4 Mini research project and creative expression	2 weeks	Guide students in selecting a topic or question they want to explore further. Assist students in formulating a clear research question related to their chosen topic. Encourage students to spend some walking and thinking time and brainstorming and proposing possible hypotheses. Ask students to compile their findings, thoughts, and hypotheses in their notebooks.

Suggested script

On Curiosity

Einstein looked at Pat and simply asked, 'Does not the question of the undulation of light arouse your curiosity?' … 'Yes, very much', said the boy, his interest brightening. 'Is not this enough to occupy your whole curiosity for a lifetime?' 'Why, yes,' said Pat, smiling rather sheepishly. 'I guess it is.' 'Then do not stop to think,' said Einstein, 'about the reasons for what you are doing, about why you are questioning. Curiosity has its own reason for existence. One cannot help but be in awe when he contemplates the mysteries of eternity, of life, of the marvellous structure of reality. It is enough if one tries merely to comprehend a little of this mystery each day. ***Never lose a holy curiosity.****'*

Above is an excerpt from 2016 Wilkins–Bernal–Medawar lecture The curious history of curiosity-driven research, delivered by Jon Agar, Professor of Science and Technology Studies at UCL. Please read this enlightening article as an introduction to the value of curiosity.

Why Curiosity Notebooks?

"The unexamined life is not worth living." — Socrates

"I have no special talents. I am only

At the core, keeping a curiosity notebook teaches students how to think for themselves, to make sense of the world and themselves.

The notebook is a sacred, distraction-free space for true self-expression, which is a very rare resource in today's world, one that must be actively cultivated and fiercely protected. With a pen and paper, it is just you and your own thoughts. It might feel scary, and or even painfully boring at first. But if one is willing to stick with it, magical things can happen.

Once students get into the habit of recording their thoughts and questions down in a curiosity notebook, they put themselves in an advantageous position to get to know themselves more deeply, and by analogy, the people and world around them.

Instruct students to keep all their notes in one notebook, whether they are attending a science or art class, whether they have just woken up from a dream or are on their way back home. Allow themselves to observe the world around them and their own mind.

Encourage your students to challenge the idea that, as they move into different spheres of their education or their lives, they are separate worlds. See if they can find any interesting connections between these worlds.

Unlike the typical essay or assignment, there is no required structure nor medium. They can write, draw, collage etc. with as little or as much structure as they want. Frame this project as a

very exciting, autonomous space where students can be themselves completely, without judgement (but you must establish this trust first).

Ideally, give students time to make and invest in their notebooks and transform it into a treasured possession.

GCSE Chemistry Lesson

KS3 Curriculum links

Chemistry:

Chemical changes

Energy changes in chemistry