

**Genre-based Approach to Enhancing Secondary Students' English Writing Ability in Science Subjects**

City University of Hong Kong, Department of English

&

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**Lesson 1: What do scientists do?**

**Intended learning outcomes**

By the end of this tutorial, students should be able to:

* Understand what scientists do.
* Know something of how scientists talk about what they do.
* Identify the basic sequences of a scientific investigation
* Identify different scientific text types and explain their communicative purpose

Note that there are video clips and a power point that go with this lesson.

A couple of the texts introduced in this lesson will be difficult for the students to understand fully. It is important that the students should not be intimidated. They only need to understand the major differences between the styles of the different texts.

Wherever students seem to have problems with vocabulary, try to get them to guess meanings from context first. As last resort, refer them to the wordlist at the end of the lesson notes.

**Introduction**

*This tutorial is divided into 3 main sections. The first section explores what the qualities of a good scientist are, including the role that good English communication skills play.*

*The next section introduces the concept of ‘scientific method’ and considers the different steps in doing scientific research.*

*The final section considers how scientific English texts vary according to who is writing them, who is reading them, and what their purposes are. This is a very important to understand, because writing well in English for science is not just about getting the grammar and spelling right, it is also about using a style of writing that is appropriate to who will read it and what is your purpose in writing it.*

*Note: In many of the tasks in this lesson and in later lessons, you may not need to understand every single word used in the sample texts. However, if you come across a word or that you do not understand and that you think may be important to understand, first try to work out its meaning from the context. If you are still not clear about the meaning, look at the list of words and phrases at the end of the lesson notes and see if it is explained there. If it is not there, look up the word or phrase in a dictionary or ask your teacher.*

Let students read this through and then ask a few q’s to check their understanding

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|  | ***Task 1: Profile of a research scientist*** |

1. **Features of a scientist**

Discuss the following questions with a partner:

 *Note that this is a discussion task that is designed to get students to think about some of the content that they will encounter in the video clips. There are no right answers, though obviously some answers will be more reasonable than others.*

*Another purpose of this task is to get students used to forming and working in groups. You will probably need to go around the groups and stimulate discussion when necessary. If time permits, at then you could ask each group to briefly feedback to the class.*

*Some possible prompts:*

1. **What does it take to be a “good” scientist (e.g. personality, skills?)**

*if the groups cannot find anything to say, you can start them off by asking the following questions?*

* + Is it better to be a shy person? Outgoing person? Be careful or be careless? Be good at Math, or computer skills? Is it important to have imagination? Creativity?
1. **What types of activities do scientists do?**

*if the groups cannot find anything to say, you can start them off by asking the following questions?*

* + Do they just collect data? Do they do laboratory work? Do they ask people questions?

*Try not to spend more than 15 minutes on this part.*

1. **What makes a good scientist?**

Watch the following short videos by research scientists and describe what they think is needed to make a good scientist. Take notes on the following questions:

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| Suggested procedures (vary this according to level/needs of the students)1. Show students the questions (ppt) - check understanding2. Play 1st video clip once3. Check how well they can answer the questions4. Introduce vocab: *solitary* and *entire*. Check students' understanding (*solitary* : "alone", "by oneself"; *entire:* "whole, "complete").5. Play video again6. Check students' answer to questions7. Show clip 1 transcript (ppt).8. Ask students to explain why the woman mentions "electrical wires" and "lights flashing"9. Show Q's for clip 2 and check understanding. (*requirement* noun from "require". Something we "require" is something we "need". A requirement is a need.)10. Play clip and check how well they are able to answer the questions .11. Introduce vocab and check understanding. *ingredients*: what something is made of, e.g. ingredients of a cake may include flour, sugar, eggs, water; *drive* (noun) means determination, being willing to work hard to achieve something; *motivated* (adjective) willing or keen to do something; *ironically*: differently from what we might expect.12. Play clip again and check students now can answer all the questions.13. Show transcript in ppt. |

Relevant extracts of the tapescripts are provided for each question below.

*\*Don’t worry if the students do not understand every word. Show the transcripts to students and go through the content after watching.*

Video 1: Phillippa Marrack, PhD [File name: T1 Marrack-BAS.mp4]

1: What is misunderstood about scientists?

*Tapescript*: One of the most misunderstood things about science is that people believe that scientists are people with electrical wires and lights flashing in their hair or whatever. And they sit around in their offices and they crab away, or [in] their labs, and they're very solitary kinds of people.

2: What kind of skills do scientists need in their job?

*Tapescript*: It involves skills with understanding, being friendly, knowing these people, having a good time with these people, talking to them, cooking them a meal, whatever it is.

3: What does she say is ‘really great’ about science?

*Tapescript*: One of the most wonderful things that can happen is to find something out that you had no idea that it was going to be there at all. And then, all of a sudden, the entire picture of what we've been interested in for 30 years is completely different.

Video 2: Joseph S. Takahashi, PhD [File name: T2 Marrack-BAS.mp4]

 4: What characteristics of a good scientist does he mention?

*Tapescript*: I would say one of the most important ingredients is curiosity. You really have to be just naturally inquisitive and curious about the world around you.

 5: What is the most important aspect of being a scientist?

*Tapescript*: But I think the most important aspect is drive. They really have to be motivated to understand and answer that question.

6: What is the most difficult requirement?

*Tapescript*: And so one of the most important features, ironically, for scientists is the ability to write. It turns out that that is perhaps the most difficult requirement, ultimately, for being a good scientist.

Look back at the four questions in part A above. Have you changed your mind about any of them?

*Note that at this point some students may come up with the idea that in addition to other qualities, scientists also need to be excellent communicators. You can ask students whether scientists need to be excellent communicators in English, and why. I would expect them to say that English is used as a global lingua franca in scientific communication, and that scientists need English in order to be able to share their work throughout the world.*

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|  | ***Task 2: the basic sequences of a scientific investigation*** |

1. **Matching exercise**

Here are some phrases (labelled (a) to (e)) that describe things that scientists do. Can you match these phrases with the descriptions given below them (labelled 1 to 5)? Remember to check the list at the end of these notes for any words or phrases you don’t understand.

*In this task, students consider the process of scientific discovery.*

*Try to draw their attention to how the steps in this process rely on effective language skills (e.g. reading, researching, writing, presenting etc.), especially (in today’s globalized world) effective English language skills.*

(a) Form a hypothesis (plural = hypotheses)

(b) Obtain data

(c) Analyze data

(d) Report results

(e) Coming to conclusions

1. Look for patterns in their data. The scientists might do this by using calculations or statistics, by comparing data, by grouping data etc.

2. Find some information that can help them test their hypothesis. They might do this by observing, by counting, by measuring, by interviewing, by doing experiments etc.

3. Make a statement about something (a) that the scientists have some reasons to think may be true, (though they are not sure); and (b) that they think is possible to test, i.e. they will be able to find evidence to show whether it is true or not.

4. Interpret their findings and decide what is most interesting or significant.

5 Prepare to communicate their findings. They might do this by describing, comparing and contrasting in words and by using tables and graphs etc.

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| (b) Obtain data |  2. Find some information that can help you test your hypothesis. You might do this by observing, by counting, by measuring, by interviewing, by doing experiments etc. |
| (c) Analyze data |  1. Look for patterns in your data. You might do this by using calculations or statistics, by comparing data, by grouping data etc. |
| (d) Report results |  5. Prepare to communicate your findings. You might do this by describing, comparing and contrasting in words, by using tables and graphs etc. |
| (a) Form a hypothesis |  3. Make a statement about something that (a) you not sure is true or not; (b) you would like to find out if it is true or not, and(c) you think it may possible to find out whether it is true or not  |
| (e) Coming to conclusions |  4. Interpreting your results and deciding what is most interesting or significant. |

**B. Forming and testing hypothesis**

1. In groups, think of at least two hypotheses about either (a) your classmates, (b) your school, (c) the area you live in (d) your family and friends.

2. Suggest how you might obtain data to test these hypotheses.

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|  | ***Task 3: Describing different kinds of writing in science communication***  |

**A. Examining Three Scientific Texts**

Below are three texts on the topic of oxygen. Read them through and discuss the following questions. Note that you do not need to understand every word in the texts. However, if you do want to check any of the words that are underlined, , you will find them in the list at the end of this lesson.

1. Where do each of the texts probably come from (e.g. Wikipedia or similar online source? An article in a professional scientific journal? A textbook? etc.)

*Might need to suggest possibilities: Wikipedia? A Form 3 science textbook? A Form 1 science textbook? A “Science for Kids” Website? A scientific journal?*

2. What kinds of reader is each text probably intended for? (e.g. likely age, educational level; knowledge background)

*Suggestions: A well-educated adult with some basic scientific knowledge? A form 3 student; A form 1 student? Someone who knows almost nothing about science? A professional scientist?*

3. How would you order the three texts in terms of how scientific their language is (from “very scientific/technical” to everyday/popular)?

*Least to most scientific: 2,1,3*

4. Which text contains the most information?

*3*

5. Which text is the longest?

*1*

6. Which text is the shortest?

*3*

*Implication: Amount of information is not directly related to length of text. More important is how DENSE the text is (how information is ‘packed together”)*

7. Which text is the hardest for you to understand?

*Hope they will say text 3*

8. Which text is the easiest for you to understand?

*Hope they will say text 2*

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| **Text 1** |
| Oxygen is an important element that is needed by most life forms on earth to survive. It is the third most abundant element in the universe and the most abundant element in the human body. Oxygen has eight electrons and eight protons and it is located at the top of column 16 in the periodic table.Under standard conditions oxygen forms a gas that is composed of molecules consisting of two oxygen atoms (O2). This is called a diatomic gas. In this form oxygen is a colourless, odourless, tasteless gas. Oxygen is found all around us. It is one of the most important elements on planet Earth. Oxygen makes up around 21% of the Earth’s atmosphere and 50% of the mass of the Earth's crust. The oxygen that is found in the air is produced in plants by the process of photosynthesis. Without plants, there would be very little oxygen in the air. In the solar system, only the Earth has a high percentage of oxygenOxygen is an important element to life on Earth and both plants and animals use it in respiration. It is the most abundant element in the human body making up around 65% of the body's mass. Oxygen atoms make up an essential part of the proteins and DNA in our bodies.Tanks of oxygen are used in medicine to treat people with breathing problems. They are also used as life support for astronauts and scuba divers. The majority of the oxygen used in industry is used in the manufacturing of steel. Other applications include making new compounds such as plastics and creating a very hot flame for welding. Liquid oxygen is combined with liquid hydrogen to make rocket fuel. Swedish chemist C. W. Scheele first discovered oxygen in 1772. He called the gas "fire air" because it was needed for fire to burn. Scheele did not publish his results right away and the element was independently discovered by British scientist Joseph Priestley in 1774.  |

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| **Text 2** |
| ***Oxygen*** is the name of a gas that is in the air that we breathe. Although it has no taste, no smell and no colour, it is a very important gas. If there were no oxygen in the air most living things on Earth (including us) could not live. We need oxygen to make many parts of our bodies.Plants produce oxygen from another gas in the air called *carbon dioxide*. Plants are able to separate carbon dioxide into carbon and oxygen by using sunlight. If there were no plants, there would be hardly any oxygen in the air at all. The Earth is the only planet in our solar system that has so much oxygen in its air. If someone has difficulty breathing, doctors use tanks full of oxygen to help them. Tanks of oxygen are also used by people who dive deep under the sea and by astronauts who travel into outer space. We also use a lot of oxygen in making steel. If you cool down oxygen enough, it becomes a liquid and liquid oxygen is one of the ingredients used to make rocket fuel.A Swedish chemist called C.W. Scheele first discovered oxygen in 1772. He called the gas "fire air" because fire needs oxygen in order to burn. However, Scheele did not publish his results right away and oxygen was discovered again in 1774 by the British scientist Joseph Priestley, who did not know that Scheele had already discovered it. |

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| **Text 3** |
| **Oxygen** is a chemical element with the symbol O and atomic number 8, meaning its nucleus has 8 protons. It is a member of the chalcogen group on the periodic table. It is a highly reactive nonmetal, and an oxidizing agent that readily forms oxides with most elements as well as with other compounds. By mass, oxygen is the third-most abundant element in the universe. At standard temperature and pressure, two atoms of the element bind to form dioxygen, a colourless and odourless diatomic gas with the formula O2. Diatomic oxygen gas constitutes 20.8% of the Earth's atmosphere. Dioxygen is used in cellular respiration and many major classes of organic molecules in living organisms contain oxygen, such as proteins, nucleic acids, carbohydrates, and fats, as do the major constituent inorganic compounds of animal shells, teeth, and bone. Oxygen is continuously replenished in Earth's atmosphere by photosynthesis, which uses the energy of sunlight to produce oxygen from water and carbon dioxide. Oxygen was isolated by Michael Sendivogius before 1604, but it is commonly believed that the element was discovered independently by Carl Wilhelm Scheele, in Uppsala, in 1773 or earlier, and Joseph Priestley in Wiltshire, in 1774. Priority is often given for Priestley because his work was published first. Uses of oxygen include production of steel, plastics and textiles, welding and cutting of steels and other metals, rocket propellant, oxygen therapy, and life support systems in aircraft, submarines, spaceflight and diving. |

1. **Comparing different ways of expressing the ‘same’ information**

*This task may be difficult/unfamiliar to students unaccustomed to thinking about grammar and vocab systematically. Its purpose is to just start them doing so. Adapt accordingly. They are likely to need considerable scaffolding to put into words what thy notice.*

*Try to respond to whatever students come up with but here are some suggestions for what might be noted.:*

Look at the table below which contains passages from the three texts that cover roughly the same information. What differences are there in the ways similar information is expressed? Use the following questions to guide your discussion of this.

1. Are there places where everyday words are used in one passage and more formal or more scientific words are used in another?

2. Where scientific words are used, are they general scientific words that any educated English-speaking person might know, or are they words that only people who have studied science to an advanced level might know?

3. Are there places where similar information is expressed in grammatically different ways? For example, by different parts of speech (nouns, verbs, adjectives etc.) or by different sentence structures (e.g. active versus passive voice; simple sentences v. complex sentences)?

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| *TEXT 1* | *TEXT 2* | *TEXT 3* |
| *1.A simple sentence with only one ranking clause (the relative “that”-clause does not count as a ranking clause because it is part of the noun. group/phrase)* *2. “life on earth” ‘compact” noun rather than V+ing form + noun etc. – less explicit (?)**3. “survive”more technical/scientific than “live”* | 1. Complex sentence (2 ranking clauses, conditional structure) 2. “most living things on Earth” (v. “life on Earth)3. “live” not “survive”4. “including us” – personal element. |  |
| 1. simple sentence 2. Scientific word/noun ‘photosynthesis” with no further explanation | 1. Two sentences. 2. Explains process and does not give scientific term  | 1. One complex sentence (the “which”clause is not part of a noun group)2. Gives scientific term and explains process (with an ‘elaborating’ clause)3. Other scientific/semi-scientific terms: “atmosphere” (not “air), replenish |
| colourless, odourless, tasteless (morphologically more complex less ‘everyday words than “has no c;oour etc.  | … it has no taste, no smell and no colour (rathet than colourless etc.)  | also ” colourless and odourless” not ‘has no colour etc.)Additional scientific term “diatomic”  |
| Without plants, there would be very little oxygen in the air. | If there were no plants, there would be hardly any oxygen in the air at all. |  |
| Oxygen atoms make up an essential part of the proteins and DNA in our bodies. | We need oxygen to make many parts of our bodies. |  |
| Tanks of oxygen are used in medicine to treat people with breathing problems. | If someone has difficulty breathing, doctors use tanks full of oxygen to help them | *…* oxygen therapy ... |
| The majority of the oxygen used in industry is used in the manufacturing of steel. | We also use a lot of oxygen in making steel. | Uses of oxygen include production of steel… |
| They are also used as life support for astronauts and scuba divers. | Tanks of oxygen are also used by people who dive deep under the sea and by astronauts who travel into outer space. | … and life support systems in aircraft, submarines, spaceflight and diving. |
| Liquid oxygen is combined with liquid hydrogen to make rocket fuel. | If you cool down oxygen enough, it becomes a liquid and liquid oxygen is one of the ingredients used to make rocket fuel. | Uses of oxygen include production of … rocket propellant |

1. **Closer examination of grammatical differences**

Look at each text as a whole and try to answer the following questions:

*If the students are weaker than expected this part can be omitted*

1. Which text has the largest number of long noun groups?

*Note that we are using ‘noun groups’ (following the Cobuild Grammar) rather than noun phrases. But use whatever students are familiar with (if they are familiar with anything!).*

2. Which texts has the largest number of short noun groups (including single nouns)?

3. Which text has the largest number of complex sentences?

4. Which text has the largest number of simple sentences?

**D. Final discussion**

1. Of all the features of vocabulary and grammar that you have noticed in these texts, which are used more in texts that use scientific language, and which are used more on texts which use less scientific language?
2. Of all the features of scientific English that you have identified so far, which might be difficult for you to use correctly if you had to write a scientific text?

Glossary

**Introduction**

Appropriate (合適) *adj*: something that is correct or suitable in a particular context or for a particular purpose.

**Task 2A**

Hypothesis (假設)*noun* : an idea or explanation that is based on known facts but has not yet been proved**.**

Interpret (翻譯) *verb*: to decide or work out what the meaning or significance of something is.

Analyze (分析) *verb***:** to study something in detail in order to explain it.Note that it is spelled ‘analyse” in UK English.

Sequence (順序) *noun*: The order in which related things follow each other, i.e. what comes first, what comes second etc.

Compare (比較) *verb*: To find similarities.

Contrast (對比) *verb***:** to find differences.

**Text 1**

Abundant (豐富) *adj*: existing or available in large quantities; plentiful.

Electrons (電子) *noun*: a [tiny](https://www.collinsdictionary.com/dictionary/english/tiny) particle of [matter](https://www.collinsdictionary.com/dictionary/english/matter) that is smaller than an atom and has a negative [electrical](https://www.collinsdictionary.com/dictionary/english/electrical) charge.

Protons (質子) *noun*: a very small piece of [matter](https://www.ldoceonline.com/dictionary/matter) with a [positive](https://www.ldoceonline.com/dictionary/positive) [electrical](https://www.ldoceonline.com/dictionary/electrical) [charge](https://www.ldoceonline.com/dictionary/charge) that is in the [central](https://www.ldoceonline.com/dictionary/central) part of an [atom](https://www.ldoceonline.com/dictionary/atom).

Periodic table (原素表) *noun*: a table of the chemical elements arranged in order of atomic number

Molecules (分子) *nouns*: form when two or more atoms form chemical bonds with each other

Odorless (無味的) *adj*:having no smell. Note that it is spelled ‘Odourless” in UK English.

Crusts (硬殼) *noun*:the tough outer part of something.

Photosynthesis (光合作用) *noun*:a process used by plants and other organisms to [convert](https://en.wikipedia.org/wiki/Energy_transformation) [light energy](https://en.wikipedia.org/wiki/Light_energy) into [chemical energy](https://en.wikipedia.org/wiki/Chemical_energy).

Scuba divers (潛水員) *noun*:people who scubadive, i.e. swim under water using a special type of equipment for breathing.

**Text 2**

Solar system (太陽系) *noun*: the sun and the group of planets that move around it.

**Text 3**

Cellular respiration (呼吸作用/細胞呼吸) *noun*: the process through which cells convert sugars into energy.

Convert (轉換) *verb*: to change something and make it into something new.

The universe (宇宙) *noun*:all of space and time and their contents, including planets, stars, galaxies, and all other forms of matter and energy.

Steel (鋼) *noun*: a strong metal that is a mixture of iron and carbon.

Textiles (紡織品) *noun*: a cloth made by hand or machine.

Braze (硬銲) *verb*: joins metals by melting and flowing a filler metal to the joint.

Weld (焊接) *verb*: joins metals by melting the base metal and causing fusion.

Propellant (燃料) *noun*:fuel that to create movement of the rockets.

Aircraft (飛機) *noun*: a machine that can fly, e.g. plane, helicopter.

Submarine (潛艇) *noun*: a ship that can travel underwater.

Spaceflight (太空飛行) *noun*: space travel