Teaching the Language of Climate Change Science

TEXT ANALYSES: CHAPTER 8 YEARS 7-8

Teachers of Years 7_8 students: please don't feel daunted by all the grammatical information provided in these text analyses. It is helpful to display the whole text so you can teach how a text is logically structured (the information in the left-hand column). When it comes to teaching language and grammar resources (right-hand column), choose one or two paragraphs to teach thoroughly, taking sentences, noun groups and phrases apart and put them back together again so that students understand how a good paragraph is structured. *Don't try to cover every little thing in every paragraph.* You'll all cry!

Focus text: life in the balance - ecosystems (p 116)

Structure	Text	Language resources
Question as heading Topic sentence answers heading, provides definition. Tell us more: scale Tell us more: significance One example Tell us more: non-living elements and living elements	**What is an ecosystem?** An ecosystem includes all living things (plants, animals and other organisms, known as the biota) in a given area, and the non-living elements (e.g. sun, soil and climate, known as the abiota). Ecosystems can be as small as a rockpool, or as large as a continent. The health of ecosystems influences the health of the entire planet. One example of an ecosystem is found in the Antarctic, a polar habitat. The Antarctic consists of ice and snow on top of rock. It is considered a desert because there is little rain. Some small shrubs, lichens, mosses and algae grow, but no trees.	Definition: 'ecosystem' on one side of 'includes' and one massive noun group on the other (underlined). Brackets are used for elaboration of some terms. Where terms are powered down (e.g. living things), the powered up term is added afterwards (e.g. known as the biota). 'Ecosystem' is a generalisation that encapsulates that whole noun group. Modality: 'can be' implies possibility but not certainty. Comparatives used here: 'as small as…', 'as large as…'. Repetition of 'health' supports the cohesion of the para. Modality: 'the *entire* planet' for emphasis. Notice that 'ecosystem' is at the front of the para to introduce the example, the Antarctic. (could have written it in reverse, but this way links better to previous para. Verbs 'is found', 'consists of', 'is considered' all function to launch new information about the Antarctic. Very useful in information reports like this.

Nominalisation as heading (mini explanation) Phenomenon identification Stage 1: Producers Stage 2: Consumers -carnivores -herbivores Stage 3: Decomposers Stage 1 One example: Antarctic (matches para above) Stage 1: producers Stage 2: Consumers (first level) Stage 2: Consumers (second level) Stage 3: Decomposers	**Energy flow in an ecosystem** In an ecosystem, each organism exchanges energy through its feeding relationships. This is known as the food chain. Food chains begin with plants. Plants produce food using energy from the sun. Organisms that eat plants or other animals are called consumers. Consumers cannot make food from the sun's energy. Some organisms eat only meat (carnivores), and some eat only plants (herbivores). When organisms die, their bodies are broken down by microbes, and the chemicals (like carbon and nitrogen) from their bodies feed the microbes and also go back into the soil. Thus the cycle begins again. Food chains in the Antarctic are very short. The producers are ocean-growing plants. The first-level consumers are krill. Krill are eaten by many predators, including whales, seals, birds, fish and squid. Other predators are penguins, which in turn are eaten by seals. The decomposers in the Antarctic are bacteria.

Heading (causal explanation) Topic sentence Human-induced climate change Effect 1 Effect 2 Effect 3 Effect 4	The effect of climate change on food webs Ecosystems can be disrupted by natural events, or by human intervention. Anthropogenic climate change is causing disruption to ecosystems around the world. This can be catastrophic. As the oceans are warming because of climate change, phytoplankton and krill populations are dropping. Without these producers and first-level consumers, the food web in the Antarctic would be in a precarious state.	Three nominalisations in heading: 'the effect', 'climate change', and 'food webs'. Each concentrates lots of meaning into one little noun group Verb in passive voice 'can be disrupted by' enables 'ecosystems' to go at front of sentence in prime position. Technical terms: 'anthropogenic' means 'human-induced' but is useful step into sounding scientific. 'As the oceans…' is cause – 'phytoplankton…' is effect. 'Without…' phrase is foregrounded at front of sentence for prominence. Emotive adjectives: catastrophic, precarious.

Focus text: renewable and non-renewable energy sources and climate change (p 121)

Structure	Text	Language resources
Heading Topic sentence Definition of renewable and non-renewable (time scale) Issue with non-renewable	Energy sources and the human timescale People need energy to run machines, produce goods and for transport. Some of the Earth's energy sources are non-renewable, and some are renewable. It depends on how long it takes to replenish the supply. (Renewable sources are expected to be replaced within our lifetime, i.e. approximately 100 years.) For hundreds of years, humans have relied on non-renewable fossil fuels, but this has created problems for the planet.	
Heading (mini-explanation) Phenomenon identification Stage 1 (elaborations for coal, oil and gas) Stage 2 Reason for their label as non-renewable	Non-renewable energy sources Coal, crude oil and gas are non-renewable fossil fuels. They were formed over millions of years, from the remains of dead organisms. Coal was largely formed from decaying plants while oil and gas were formed from huge quantities of microscopic animals, plankton and algae falling to the bottom of the ocean and being covered by layers of mud. Over millions of years this organic material was subjected to intense pressure and heat, and slowly transformed into oil and natural gas. Given that the timescales for the formation of coal, oil and gas are so huge, fossil fuels are considered non-renewable. They are a finite resource. Burning fossil fuels is one of the most significant causes of climate change. It produces carbon dioxide, a greenhouse	Nominalisation Non-renewable fossil fuels: generalisation of the three 'were formed' is verb in passive voice: the 'doer' is the dead organisms. 'while…' dependent clause telling us these events were happening at the same time. Time phrase: over millions of years at front of sentence to emphasise and signal new stage. 'was subjected to…' verb in passive voice 'Given that… is dependent clause of concession, placed at front of sentence for emphasis. 'Are considered…' verb in passive voice 'Burning fossil fuels' is a clause acting as a noun. More big noun groups here: lots of qualifications added on after the noun.

	gas that traps heat inside the atmosphere. Many alternative renewable and non-polluting energy sources are now being investigated and harnessed.	'Are now being investigated and harnessed…' more verbs in passive voice. The reason for passive voice here is often that the 'doers' are general and don't need to be named, e.g. scientists and engineers.
Energy source and how it is accessed Pros Cons Energy source and how it is accessed Cons Pros Energy source Examples Pros and cons Energy source and how it's accessed Pros Energy source and how its accessed Pros Cons	**Renewable energy sources** **Solar energy** is harvested direct from the sun, using solar photovoltaic cells and rooftop solar water heaters. Apart from indirect emissions from manufacture and installation, it creates no greenhouse gas emissions. Solar energy is not available during the night, unless the energy is stored in batteries. **Wind** is also harnessed from the sun, because wind is the movement of air caused by uneven heating of the Earth by the sun. It is used in wind farms, where the blades of a wind turbine turn a rotor, creating electricity in a generator at the top of the tower. The downside of wind energy is that it is intermittent, and not always available unless battery storage is used. Both wind and solar energy are considered renewable energy sources. Both are inexhaustible and becoming more affordable and efficient as more large-scale farms are installed around the globe, and the technology, such as battery storage, improves. **Biofuel** is produced from recently living matter (unlike fossil fuels which are made from living matter that died millions of years ago). They can be solids, like wood and sugar cane waste; liquids, like ethanol made from corn; or gases, like methane and biogas that are produced as landfill decomposes. In Australia, about 130 local councils burn landfill gas to produce electricity. Biofuels are renewable energy sources. However, burning biofuels does create some greenhouse gases. **Hydroelectricity** is electricity generated when falling water from reservoirs or flowing water from rivers is harnessed to generate electricity. It produces few greenhouse gases. **Geothermal energy** comes from heat stored in the Earth's crust, for example in Iceland and New Zealand. The heat can be transferred directly to heat homes, schools, shopping centres and industries, or be transferred to power stations that use steam to generate electricity. Australia has geothermal resources (mostly in South Australia and Victoria) but the hot rocks are deep in the Earth, which right now makes it difficult and expensive to extract.	
Factorial explanation: Phenomenon Effect 1	**Why renewables?** Using renewable energy has many benefits for the Earth. Firstly, it can help to mitigate climate change because it	'Using renewable energy' is clause acting as noun. Firstly, etc… connectors to stage the explanation Complex sentence with 'because' clause: clause of reason

Effect 2 Effect 3 Effect 4	creates no direct greenhouse gas emissions. Secondly, it can decrease air pollution and is better for our health. Thirdly, it is a reliable source of power because it will never run out. Renewable energy is becoming more affordable, and its impact on climate change will be very important.	Connector 'Secondly…' begins compound sentence: two factors joined with 'and'. Connector 'Thirdly…' Another 'because' clause of reason. Note change in tense in final sentence: 'is becoming' and 'will be' looking to the future.

Focus text: the causes of sea level rise (p 135)

The structure of this text is interesting. It is a series of embedded explanations. Overall it is a factorial explanation, explaining that 2 factors are contributing to sea level rise. Each factor in turn, is a mini causal explanation, which explains the sequence of events which make up the phenomenon of warming oceans, or melting glaciers. When the text shifts to providing one example, i.e. the Thwaites Glacier, the same embedded explanations appear again.

Structure	Text	Language resources
Factorial explanation Phenomenon identification Foreshadowing of causes	**Introduction** Sea levels on Earth have risen and fallen over millennia. However, in the past few decades, sea levels have begun to increase significantly because of climate change. Over the past 100 years, sea levels have risen 160 to 210mm. About half of the increase has occurred since 1993. The Antarctic continent is currently losing about six times as much ice as it was in the 1980s. There are two main reasons for this increase in sea level rise: warming oceans and melting land ice.	Technical terms: millennia, climate change. Use of numerical data typical of scientific writing. Cohesive devices: -Connector: 'However…' links this sentence to the previous one with a conjunction of exception. -Ellipsis (repeated words left out): 'About half of the increase [in sea level]… Time phrases to provide scale of phenomenon 'over millenia, in te past few decades, over the past 100 years.
Factor 1 (mini causal explanation) Topic sentence Stage 1 Stage 2 Stage 3 Stage 4	**Warming oceans** Around the globe, <u>increased temperatures in the atmosphere</u> are causing the oceans to heat up. As heat is added to water, the molecules gain energy and move faster and faster. This causes the liquid to expand, and this is one of the reasons for global sea level rise.	'Where' phrase to show extent of problem. Nominalisation made into a big noun group (underlined) Words to show cause and effect: 'is causing', 'one of the reasons'. Time clause 'As heat is added…' helps to sequence the explanation. 'This' refers back to the entire process in previous sentence.
Factor 2 (mini causal explanation) Topic sentence and opening para: why this phenomenon is relevant to Australians.	**Melting land ice** While ice does not appear to play <u>an important role in the lives of most Australians</u>, scientists warn that <u>changes happening at the poles</u> affect the entire globe. The Arctic region is warming two to three times faster than other areas on Earth. <u>Most of the world's ice</u> is located at the poles, and it is <u>the melting land</u>	Time clause opens the sentence: 'while…'. It pre-empts a possible objection to worrying about the Antarctic. Modality: 'entire globe', 'most of the world's ice.

Phenomenon identification Stage 1 Stage 2 Stage 3 Stage 4	ice that has scientists concerned. In Antarctica and Greenland – both land masses covered with ice – increased temperatures are causing the ice to melt. Around the world, many glaciers, made of ice, are melting at a faster rate. Ice is a solid, and the molecules are tightly bound and do not easily move. For this reason, land ice stays on top of rock, and does not increase the sea level. When the solid turns into liquid, I.e. when ice is melted, the molecules are loosely bound and flow easily. The water flows into the sea, increasing the sea level.	Nominalisations: increased temperatures 'For this reason' – shows cause and effect Other cause and effect relationships have to be inferred: e.g. when ice is melted… the water flows into the sea, *increasing*…
Topic sentence situates the glacier Phenomenon identification Factor 1 Factor 2 Further explanation Stage 1 Stage 2 Stage 3 Stage 4 Comment	## One example: Thwaites glacier Thwaites glacier is a huge glacier in the western Antarctic. Anthropogenic climate change is causing the glacier to melt in two ways. Firstly, it is warming the air, melting the glacier from above. Ice at the front of the glacier is changing state from a solid to a liquid. Secondly, warm ocean water is undermining the glacier from below, resulting in the face of the glacier slipping into the ocean, leading to further changes in state from a solid to a liquid. Ice loss has more than doubled in the past 30 years. Much of the land covered by Thwaites glacier is below sea level. Consequently, the sea water is more easily able to melt the underside of the glacier. As the ice lifts off the land underneath, more ice breaks off and drifts away, eventually melting. The 'grounding line', the place where the glacier rests on the rock, has moved 14km since 1992. Scientists estimate that the total collapse of Thwaites glacier would add half a metre to the sea level, and scientists caution that this could cause other low-lying glaciers to collapse.	
Effect 1 Elaboration (nominalisations) Elaboration	## The impact of sea level rise Sea level rise is already impacting low-lying coastal communities such as Kiribati. The effects are flooding and erosion from storm surges, the destruction of housing and displaced people. The ingress of sea water onto farmlands makes the land unusable for farming.	
Action	## What we can do Understanding the devastating impacts of sea level rise around the globe, we have to do everything we can to reduce greenhouse gas emissions and slow down climate change.	

Focus text: from carbon to carbon dioxide (p 143)

Structure	Text	Language resources
Question as heading Definition of chemical change Definition of substance Reversibility	### What is a chemical change? A chemical change is produced by mixing two or more substances to produce a new substance. (A substance is matter with uniform properties.) Some chemical changes are reversible, but not easily.	
Heading General definition. How they link to first para (chem changes) Chemical change for CO2 Chemical change for methane	### Natural sources of carbon dioxide and methane Carbon dioxide and methane are both colourless, odourless gases that exists in the Earth's atmosphere. They are the result of chemical changes. To create carbon dioxide, one molecule of carbon combines with two molecules of oxygen to produce a new substance (carbon dioxide, CO2). To create methane, one molecule of carbon and four molecules of hydrogen combine to produce a new substance (methane CH4)..	
CO2 (Natural) Source 1 (respiration) (powered down explanation) Source 2 Source 3	*Natural sources of carbon dioxide* Carbon dioxide is created naturally in respiration processes inside living organisms and micro-organisms. (In other words, the chemical changes happen inside the bodies of organisms as they breathe.) When organisms die, decomposition of their bodies also produces a chemical change resulting in carbon dioxide. It is also the product of volcanic outgassing and of the combustion of organic material, such as in bushfires.	

Methane (natural) Source 1 Source 2	*Natural sources of methane* Methane is created naturally when ruminant animals, such as beef cattle, ferment their plant-based food in their stomach prior to digestion, and belch out the gas. Methane is the largest component of natural gas, which we use for cooking and electricity.	
Natural processes (explanation) Definition CO2 Factor 1 -Stage 1 -Stage 2 Factor 2 -Stage 1 -Stage 2 Methane -Stage 1 -Stage 2	How the Earth keeps carbon dioxide and methane in balance Carbon dioxide and methane are known as 'greenhouse gases' because they trap heat at the edge of the atmosphere, and keep Earth at a habitable temperature. Carbon dioxide is kept in balance in two ways. Firstly, it is absorbed by plants. The process of producing food creates a chemical change that also produces oxygen for animals to breathe. When organisms die, the carbon is captured in the soil. Secondly, the oceans are a major carbon sink. Carbon from carbon dioxide is captured in the shells of small animals, and sinks to the bottom of the ocean. Methane is naturally kept in balance by a chemical reaction that happens when it reaches the troposphere (the lowest layer of the Earth's atmosphere), creating water vapour and carbon dioxide.	
CO2 (human induced) Definition: how they came about Use	Carbon dioxide sources from human activity Carbon dioxide is also produced when people dig up fossil fuels – coal, oil and gas – from the ground. Fossil fuels are the result of animals and plants dying millions of years ago and, under tremendous heat and pressure, turning into fossil fuels. Fossil fuels are used as fuel for	

Mini explanation Stage 1 (burnt) Stage 2 (changes) Stage 3 (release in air) Effect Mini explanation Stage 1 (clearing) Stage 2 (can't absorb) Stage 3 (Into oceans) Stage 4 (acidic oceans) Effect	transport and to create electricity for powering factories. When they are burnt, the combustion processes produce chemical changes that result in additional carbon dioxide being released into the air, far more than would happen naturally. This is creating far too much carbon dioxide. Instead of the Earth remaining in a stable habitable state, the atmosphere is heating up. Land clearing is also contributing to the production of carbon dioxide. When trees are cleared to build cities or for agriculture, they can no longer absorb carbon dioxide and change it back into oxygen. Absorbing additional carbon dioxide is making oceans acidic and is making the sea increasingly uninhabitable for many sea organisms.
Methane (human induced) Source 1 (cattle) Source 2 (Rice and decomposition) Effect	Methane sources from human activity Increased methane in the atmosphere comes from many human-induced sources: increased cattle production means more methane as cattle digest their food. There were approximately 1.4 billion cattle in the world in 2019, and growing. Rice production and decomposing materials in land fill also contribute methane. Permafrost in the Artic Circle has begun to melt due to increased temperatures from climate change, releasing methane that was previously stored below the ice.

Link to climate change (explanation) Phenomenon identification Stage 1 Stage 2 Stage 3 Effect Response by scientists	Carbon dioxide, methane and climate change Increased greenhouse gases are the single most important cause of anthropogenic climate change. The increase in the greenhouse gases, including carbon dioxide and methane, has resulted in an increase in average global temperature of about one degree Celsius. While this does not sound like much, one degree of warming has intensified extreme weather events including droughts, floods, hurricanes and bushfires, and in some cases freezing winter storms. The rate of increase in carbon dioxide and methane, as well as other greenhouse gases, has unbalanced the Earth's natural carbon cycle. Scientists are working to find ways of storing carbon so that it is not	This para is typical of the level of nominalisations and expanded noun groups required to sound authoritative as students move towards their final years of schooling. The nominalisations and noun groups are underlined. The more nominalisations and noun groups used, the simpler the sentence, because verbs and their circumstances have been condensed into noun groups. One way for students to understand how nominalisations work is to take a sentence like the first one, and power it down into 'commonsense spoken-like language. Compare the length and the number of clauses in the written and spoken examples.

-Example 1 -Example 2 Required response by humans and why (hortatory)	released into the atmosphere. An example is carbon sequestration. Scientists have also found algae additives to add to cattle feed that significantly reduces the amount of methane produced. All humans are responsible for reducing our energy use to slow down or reverse climate change. This way the Earth can remain habitable for all organisms.	Notice how the expanded noun groups often include a clause inside them e.g. 'cattle feed [that significantly reduces…]. The final paragraph is known as 'hortatory': a call to action.