The language of climate change science

A preschool - Year 8 teaching and learning progression

Julie Hayes and Bronwyn Parkin

Collaboration Partner

The language of climate change science

Project Managers Julie Hayes and Bronwyn Parkin

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Language of Climate Change Science Project Advisory Group

	Rose	Anderson	Aust. Science Teachers' Assoc.	Board Director, Australian Science Teachers' Association
Dr	Steven	Cork	Aust. National University	Adjunct Professor, Crawford School of Public Policy
Dr	Robyn	Cox	Univ. of New England, PETAA Board	Assoc. Professor, Head of Department, Curriculum, Member, PETAA Board
Prof.	Peter	Freebody	University of Wollongong	Honorary Professorial Fellow
Dr	Helen	Georgiou	University of Wollongong	Lecturer, Science (Physics) Education
	Julie	Hayes	PETAA Board	Formerly principal of Cowandilla PS, former president SA Primary Principals' Association, Member, PETAA Board
Dr	Lorna	Jarrett	University of Wollongong	Lecturer, School of Physics
Dr	Pauline	Jones	Uni. of Wollongong, PETAA Board	Assoc. Professor, Language in Education. PETAA President.
Dr	Aparna	Lal	Aust. National University	Researcher, National Centre for Epidemiology & Population Health
	Jacqueline	McCarthy	Science Teachers' Association, NSW	Councillor, Science Teachers' Association Board
	Marianne	Nicholas	SA Science Teachers' Association	Member, SA Science Teachers' Association Board
	Jonathan	Noble	Conservation Volunteers Australia and New Zealand	National Community Engagement Manager
Dr	Bronwyn	Parkin	University of Adelaide, PETAA Board	Adjunct lecturer and independent literacy consultant, Member, PETAA Board
Dr	Frances	Quinn	University of New England	Senior lecturer, Science Education
Prof.	Peter	Reimann	University of Sydney	Codirector, Centre for Research on Learning & Innovation (CRLI)
Dr	Frederik	Saltre	Flinders University	Research Fellow, College of Science and Engineering
Hon Prof.	Bruce	Sutton	University of Sydney	Honorary Professor, School of Life and Environmental Sciences, Faculty of Science,
Prof.	Chris	Turney	University of NSW	ARC Laureate Fellow and Professor of Earth Sciences & Climate Change
Ms	Annette	Turney	University of Wollongong	PhD Candidate, Tutor and Research Assistant
	Hayden	Wilkinson	Aust. National University	PhD Candidate, School of Philosophy
Dr	Yvonne	Zeegers	University of South Australia	Program Director: Bachelor of Education

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Why this progression

> *Sustainable patterns of living meet the needs of the present without compromising the ability of future generations to meet their needs. Actions to improve sustainability are individual and collective endeavours shared across local and global communities. They necessitate a renewed and balanced approach to the way humans interact with each other and the environment. (ACARA: Australian Curriculum Sustainability Cross-curriculum priority p1)*

Sustainability, a cross-curriculum priority in the Australian Curriculum, is a great motivator to shape and direct the focus and elaborating of the science curriculum, particularly in light of human-induced climate change. The science curriculum has the potential to support students in developing a relevant knowledge base, along with a sense of responsibility to act for the planet and its future, underpinned by strong arguments. Biological, earth, chemical and physical sciences together provide a solid body of knowledge to support understandings of the natural systems that drive climate change, and the consequences of the additional heat trapped in the atmosphere as a result of human activity. This additional trapped heat is dramatically impacting on the Earth as a system.

While Sustainability has been identified as a priority in the Australian Curriculum, teachers are left to best work out for themselves how to use the science curriculum to support student understanding of climate change and the relationship to human activity. Although climate change is not explicitly mentioned in the science curriculum content descriptions until Year 10, a deep understanding of how our actions and use of Earth's resources affect the environment and living things can be developed through all the science strands. Science topics can be taught with a systematic emphasis on developing stewardship responsibility and care for our planet and the environment.

The teaching and learning progression offered here aims to support teachers and students in gradually making the links between science and climate change at an appropriate level of understanding for each year level. Relevant science descriptors and elaborations from the Australian Curriculum Science have been selected for their relevance to climate change.

The sequence of science content descriptions outlined here provides a language-focused, logical, coherent teaching-and-learning progression in science across the early years and primary years of schooling. The focus is on the language, knowledge, understandings, and attitudes that students need to become articulate and active in mitigating the effects of climate change[1]. The teaching and learning progression has been developed by educators from the Primary English Teaching Association of Australia in consultation with an advisory group made up of representatives from science teachers' associations, and academics from a number of universities[2].

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[1]The climate change to which we refer is attributed by scientists to the additional trapping of heat in the atmosphere. The IPCC concludes a 95% probability that this is due to the emission of greenhouse gases from human activity (IPCC, 2014). It is thus known as human-induced climate change. For the sake of brevity, this has been abbreviated to 'Climate change' in most mentions in this progression.

[2] Refer to list on page 2

While other factors like overpopulation, land clearing, over-fishing, over-extraction of water from rivers and aquifers, use of pesticides, etc have led to environmental degradation and are important areas of learning for sustainability, the focus here is more narrowly on the causes and consequences of climate change. In this way, we can give time and close attention to developing useful language for mediating learning.

The progression is not just about developing scientific knowledge. In response to the three pillars of the sustainability cross-curriculum priority: Systems, World Views and Futures, we also focus on developing positive attitudes towards the planet: appreciation and respect, and importantly a sense of responsibility leading to action. It also aims to foster respect for, and trust in scientifically gathered evidence and the scientific community to provide reliable information, to explore and discover ways that people can slow down climate change so that the planet and all that is living on it survives and thrives.

The progression begins at preschool level, and continues to Year 8, harnessing the potential of the science curriculum to help design the future of the planet. The progression supports the development of informed, articulate, and active citizens, who recognise the Earth as their home, the interdependence of all living things, and who have the will and means to act in creating a sustainable future.

Key messages about human-induced climate change

For citizens to understand climate change and its impact on living things, these are the key messages that gradually unfold across the year levels through the science curriculum.

Biological science

- All living things are interdependent. We rely on each other. When habitats are affected, species die, food chains are interrupted. This affects us all. Humans are only one species of animal, but our overuse of the Earth's resources make us the biggest danger to all other living things
- Our key responses to climate change are mitigation (reducing the severity of climate change) and adaptation. In the 2015 Paris agreement, 196 countries agreed to limit the temperature increase below 1.5 degrees, in order that living things could continue to not only survive but thrive (Silberg, 2016) Adaptation occurs over generations and, for many living things, may not happen quickly enough to keep up with the changing climate. Humans have the capacity to adapt using technologies that are continually being developed.

Earth science

- We live on one planet, made up of land, oceans, and the atmosphere
- The Earth system is very sensitive to the amount of heat energy we put into the atmosphere and ocean, with far reaching impacts on living systems
- Human activities are producing carbon dioxide, other greenhouse gases and atmospheric pollution. The greenhouse gases are accumulating in the atmosphere, and act as a blanket to trap energy and heat up the planet (DAWE, 2020)
- The use of fossil fuels: coal, gas and oil, is the main cause of this heating (NASA, 2020a). We have to find cleaner ways of producing goods and services with energy sources that don't heat up the planet. There are solutions, and it will take effort to change our habits
- The polar regions influence the Earth's weather patterns, and act as 'canaries in the coal mine' for our warming planet (Borga, 2019)
- The oceans have absorbed about 90% of the heat from the enhanced greenhouse effect and this is changing weather, habitats, ocean currents and sea levels. Even if we stop putting greenhouse gases into the atmosphere now, the oceans will continue to release the accumulated heat over coming generations (NASA, 2017).

Chemical science

- All objects are made of materials, which are finite resources from the planet, whether they come from living or non-living things. We respect and look after them
- Some materials come from renewable sources, and some come from non-renewable sources. A material familiar to students, and something they can act on is plastics made from oil. Some materials are recyclable, and others are not, ending up in land-fill or in the oceans. The most important action is to reduce our use of materials, followed by re-use, and finally recycle
- The transfer of additional heat around the planet from the use of fossil fuels is leading to changes in weather and climate, including increased heat, increased cold, and extreme weather events which affect all parts of the globe. (NASA , 2020b.)

Physical science

- Almost all of the Earth's energy comes from the sun, and the energy system is a closed system
- When fossil fuels are unearthed and burnt to make electricity and fuel, the additional greenhouse gases that are released trap heat in our atmosphere and upset the system that has existed for thousands of years
- We have to find ways of generating energy that are sustainable and do not pollute or produce greenhouse gases.

Science as human endeavour

- Scientists have been observing changes in climate over decades and there is a clear consensus that this is a life-threatening phenomenon
- We can trust that scientists are always adding to, and modifying their understanding about climate change, and working hard to find ways to adapt, manage and mitigate
- Our role as citizens is to act in ways that mitigate climate change: to change our own habits of energy use, and to convince those around us to do the same.

The role of language in teaching and learning about climate change

The following progression pays close attention at each year level, and within each topic, to the language that teachers might use to explain important phenomena effectively, and to the language and literacies which are useful for students to describe, explain, and debate about what's happening to our planet, and for our futures. We draw on the English curriculum, and the Literacy capability, to do this work.

Hands-on activities are not sufficient – teachers know that abstract scientific concepts are understood and expressed through language, and that the use of a common scientific language enables concepts and knowledge to be transferred from one topic to another, and for ideas to be shared. Teaching a topic finishes when our students can articulate what they've learned by talking and writing in authoritative ways, and for different audiences**.**

The language used in science is not just for expressing content knowledge. Language is also essential to participate in scientific inquiry processes: *language for identifying and posing questions; planning, conducting and reflecting on investigations; processing, analysing and interpreting evidence; and communicating findings* (ACARA, 2016, p. 9). Teachers draw students into the inquiry process by modelling this language, supporting and enabling all students to become fully-engaged participants in science inquiry. These processes are identified in the Science Inquiry Skills substrands of Processing and analysing data and information, Evaluating, and Communicating.

In preschool and the early years of schooling, students begin to take on a scientific orientation to the world around them, using some technical terminology as they observe and describe nature and understand that humans are but one of many living things that rely on each other for life. In the primary years, their control of scientific language, both technical vocabulary and grammar develops as they describe, inform, and explain increasingly abstract phenomena.

In the middle years of schooling, students learn to argue for a position, using their scientific knowledge and language to back up their argument. They learn how to consider and critically analyse other people's positions, looking for verification and scientific evidence as they take a personal stance.

PRESCHOOL

We cannot protect something we do not love, we cannot love what we do not know, and we cannot know what we do not see. And touch. And hear. (Louv, 2005).

Prior learning

Children entering preschool come from many different cultural and social contexts. We don't know what they have learned before they arrive. Some may already be part of environmentally aware and active families, and some may not. Some may come from families with a strong connection to the country they were born in, and already feel a sense of responsibility for that country. Some may have come from countries where water is plentiful and thus have no concept of the need in Australia to conserve water.

Educators will discover a lot about children from informal conversations with them and thereby be able to make links with their prior knowledge, and be able to confirm, elaborate and develop knowledge.

Climate change science learning in the Preschool Year

In preschool, science learning happens informally. Educators model a sense of wonder about the environment and living things, and begin to raise awareness of the environment, and that humans are not the centre of the universe. We are interconnected, and interdependent with every other living thing. They model respect for, and stewardship of the resources used for everyday living. Importantly, they begin to expand children's world views through a gradual orientation to viewing the world as scientists would view it.

Importantly, children develop positive attachment with adults and other children through joyful and respectful interactions with the environment, and through literature and songs that reinforce messages about a sustainable environment. This positive attitude underpins all future learning, as in later years they continue to develop scientific knowledge.

Educators draw students' attention to living things through a scientific lens, drawing on their curiosity to think and talk scientifically. They begin to 'wonder why and how…' with a scientific orientation.

Taking action in the Preschool Year

Children in preschool act sustainably by respecting living and non-living things in their local environment, and in participating in the social practices of the class, school, and family. We use resources wisely: turning off lights, recycling food and other recyclables, conserving water.

Language learning in the Preschool Year

Children in preschool are developing language at a rapid rate. Educators support them in developing the language they need for everyday living: to interact socially, and manage emotions. The language used in science begins their scientific orientation in an informal way. This language helps them think about the natural world: to describe what they are observing; to explain why and how simple phenomena happen (e.g. a bee collecting pollen); and to hypothesise about what might happen next. Initially teachers and other adults model and explain this language: responding to, and involving students in scientifically oriented discussions at an appropriate level.

This is not the time for complex 'written-like' grammar or extended academic texts; but as children are acquiring so much new language, the opportunity is here to include some technical terms in the dialogue and explanation, as part of the 'role-play' of being a scientist, and to show off what they have learned.

There is plenty of work to do in preschool without mentioning climate change. The work done here forms the groundwork for all future scientific language and thinking.

PRESCHOOL YEAR SCIENCE TOPICS FOR CLIMATE CHANGE

	Content descriptions and elaborations from the Early Years Learning Framework	*So what? Implications for climate change*
OUTCOME 2: Children are connected with and contribute to the world	*Children become socially responsible and show respect for the environment* - use play to investigate, project and explore new ideas - participate with others to solve problems and contribute to group outcomes - demonstrate an increasing knowledge of, and respect for natural and constructed environments - explore, infer, predict and hypothesise in order to develop an increased understanding of the interdependence between land, people, plants and animals - show growing appreciation and care for natural and constructed environments	**Systems:** Plants need animals, and animals need plants, and both need supportive environments where they can survive and thrive. We are all part of one system. **World views:** We are living things, like all other living things around us. We respect all living things. Scientists help us to understand our world and solve problems. **Futures:** We look after each other, respect and care for all living things around us.

FOUNDATION YEAR

Prior learning

Students in the Foundation year of schooling have usually attended one or more years of preschool where they were exposed to sustainability learning goals, including developing attachment to nature and living things, feeling responsible for caring for the planet, and using a scientific orientation to noticing their natural environment; that is through careful observation and description, being curious and, with the help of adults, thinking about 'why'.

Climate change science learning in the Foundation Year

In the Foundation year of schooling, this work is continued. Science focuses on students understanding that living things can be both plants and animals (including humans), and that they have particular needs. The term 'survive and thrive' or 'survive and flourish' could be introduced for the first time. They learn to respect and help care for living things such as a class pet or a class garden and the insects that live there. They develop respect for their indoor and outdoor environments and practice ways of using resources sustainably. They discuss what might happen if this care is not taken. They are encouraged to explore outdoor environments, to develop a connectedness and love for it.

In Foundation, students explore change in the world around them, including changes that impact on them, such as the weather and the seasons. They understand that humans can help other living things in extreme weather events such as heat waves. They begin to develop understanding that the objects we use in our everyday life come from the Earth's resources, including those that died a very long time ago, and have been turned into coal, oil and gas. They identify and describe different kinds of materials, and begin to co-operate, as members of the class and the school, in stewardship of the Earth's resources through recycling, re-using and repurposing.

Students learn that making careful observations and wondering why and how is a core part of science. Teachers play a pivotal role here in modelling how to observe and 'think out loud', drawing students' attention to interesting phenomena, and helping with the language to express these ideas.

Taking action in the Foundation Year

Children in the foundation year of school continue being involved in the sustainable practices begun in the preschool year. They benefit from being guided by and participating with older students in the school's sustainable practices.

Language learning in the Foundation Year

In Foundation year, students continue the work begun in preschool: to describe, explain and express their appreciation for the natural world. They continue to 'try out' scientific terminology as part of their exploration.

In the Foundation year, students begin to learn how to decode and encode the written language. This carries a high cognitive load and their written language will understandably lag behind their oral language. It is therefore quite possible that their scientific knowledge will not be adequately expressed in independent writing. For this reason, language and understanding developed through classroom talk can be recorded most effectively through the negotiation of jointly constructed written texts and diagrams with the whole class or groups. Some students may be able to represent parts of their learning independently.

FOUNDATION YEAR SCIENCE TOPICS FOR CLIMATE CHANGE

	Content descriptions and elaborations from the Australian Curriculum	*So what? Implications for climate change*
BIOLOGICAL SCIENCES	*Living things have basic needs, including food and water (ACSSU002)* -Understand what living things are: plants and animals -Understand that human beings are living things (and animals) -Understand that all living things need food, water, and air; some need shelter from weather and predators -Notice how insects and plants help to meet each other's needs. - Develop an ethos of care and responsibility for the living things in our local environment helping to meet the needs of plants and animals, including ourselves, particularly in extreme weather.	**Systems:** Living things need environments where they survive and thrive. They rely on each other to meet their needs: plants need animals, and animals need plants **World views:** People are just one living thing amongst many. We live on one planet and we help to protect ourselves and other living things. **Futures:** Our actions help, not harm other living things in our local environment.
CHEMICAL SCIENCES	*Objects are made of materials that have observable properties (ACSSU003)* -Identify and describe different kinds of materials, and where they came from -Plan and practice ways of using materials thoughtfully and responsibly	**Systems:** All materials are made of matter that comes from the Earth. Reusing materials makes it easier for the system to work. **World view:** We respect and are thoughtful about the materials we use and how our use affects the planet and other people. **Futures:** To care for the planet, we recycle, re-use and repurpose where possible before we send it off as waste.
EARTH SCIENCES	*Daily and seasonal changes in our environment affect everyday life (ASSU004)* -Understand that weather is what happens right here, right now, and seasons are regular changes throughout the year -Investigate how changes in the weather and seasons might affect animals and plants	**Systems:** Daily weather and seasons have patterns across the year. In Aust., extreme weather is becoming more frequent and summers are getting longer. **World views:** We protect other living things when weather is extreme **Futures**: We help to meet the needs of other living things around us in extreme weather by providing water, food, and shelter.
SCIENCE AS HUMAN ENDEAVOUR	*Science involves observing, and using language to ask questions about, and describe changes in, objects and events* (ACSHE013) Learners explore and become familiar with their natural world, develop an emotional attachment to it, notice how it changes, and understand their place in it and responsibility for it.	

YEARS 1-2

Prior learning

In the Foundation year of schooling, students continued to explore and develop a strong attachment to the environment. They learned about living things; plants and animals, and learned that humans are animals too. Importantly, they learned about the needs of living things, and how we all depend on each other for survival. They began to develop awareness of weather and the seasons, and become conscious of the properties and sources of materials we use from the Earth.

Climate change science learning in Years 1-2

In Years 1-2, students continue to explore what it means to be a living thing, including the changes that occur through life. They learn what it means to survive and thrive, and develop empathy and respect for living things and the importance of caring for the natural environment. They observe changes that can be large or small and happen quickly or slowly. They consider how landscapes are changed for different purposes, they identify the difference between natural and managed environments and think about the impact of these changes on the quality of life for living things.

Students explore how humans rely on Earth's resources to meet their needs, and understand that these resources are finite and should not be wasted. They think about the consequences of the Earth's resources not being available. They are introduced to the idea of the flow of matter when learning about how water is used and begin to explain the reasons for not wasting water, and for using recyclable and recycled materials. They learn about how materials can be changed, and explore ways to help use our planet's resources more sustainably.

Students learn that the sun is the Earth's main source of energy, and begin to develop an understanding that living things need energy for everything we do: making objects move, and making sound and light.

Taking action in Years 1-2

Children in the early years of schooling begin to take action by caring for the needs of other living things in their local environment. They begin to understand the principles of reduce, re-use, recycle and become advocates for sustainable practices in their families and school.

Language learning in Years 1-2

Language learning in these years continues as for Foundation years: in developing a scientific orientation, teachers and students increase their use of technical terminology in describing and explaining the world. They begin to make notes of learning as a transition to recording in written form. It is likely that scientific knowledge and oral language use exceeds what many students can record independently because of the demands of learning English orthography. For many teachers and students, joint negotiation of written texts, and the joint production of class books which are then read together or independently is the most strategic pedagogic choice.

Students begin to represent phenomena diagrammatically as well as through language, and are able to interpret their diagrams through oral presentations, using some scientific language. These presentations, either jointly constructed as a class, in groups, or independently, will be an important strategy for consolidating learning. Some students may be ready to write independently, and this should be encouraged if appropriate.

YEARS 1-2 SCIENCE TOPICS FOR CLIMATE CHANGE

	Science content descriptions and elaborations	*Implications from the sustainability cross-curriculum priority*
BIOLOGICAL SCIENCES	*Living things live in different places where their needs are met (ACSSU211)* - Explore different habitats in the local environment such as the beach, bush and backyard to discover how the needs of living things are met and how we can help - Find ways to help meet the needs of other living things *Living things grow and change and have offspring (ACSSU030)* - Understand that living things live in places where they survive and thrive. When their needs are being met, they have offspring.	**Systems:** A habitat is a system where living things interact and help to meet each other's needs. **World view:** Healthy habitats need many different living things to look after each other. Humans can help other living things survive and thrive. **Futures:** We take action so that the habitats in which we live meet the needs of all living things. For example, we provide water, shelter and food when needed.
CHEMICAL SCIENCES	*Everyday materials can be physically changed in a variety of ways (ACSSU018). Different materials can be combined for a particular purpose (ACSSU031).* - Reduce, re-use and repurpose everyday materials to reduce waste of the Earth's resources including making compost, paper, engage in 'nude lunches' and recycling programs	**Systems:** All matter comes from the Earth. Reusing materials makes it easier for the system to work. **World view:** We think hard about the materials we use and how they affect the planet and other people. **Futures:** To care for the planet, we recycle, re-use and repurpose where possible before we send it off as waste.
EARTH SCIENCES	*Observable changes occur in the sky and the landscape. (ACSSU019)* -Observe the Australian landscape and our local environment across seasons and think about what that means for living things *Earth's resources are used in a variety of ways (ACSSU032*) -Describe the source of Australia's water, investigate how water is transferred, Identify stormwater systems and that this water flows into rivers and streams -Collect information about water use and develop actions for reducing waste, eg turning off dripping taps, not washing paint brushes under running water.	**Systems:** Water on the planet is one system. Water just moves around the planet in clouds, rain, rivers, and the ocean. It takes a lot of effort to get water where it is needed for living things to survive and thrive. **World view:** We respect the Earth's resources that we use, especially in Australia, water. **Futures:** We care for our planet and other living things by conserving and re-using water e.g. dripping taps, long showers
PHYSICAL SCIENCES	*Light and sound are produced by a range of sources and can be sensed (ACSSU020). A push or a pull affects how an object moves or changes shape (ACSSU033* -Recognise the sun as an important source of energy for living things -Understand that whenever we, or the machines we use, apply force to make an object move or change shape, or make a light shine, we are using energy, which comes from resources from the sun and the Earth.	**Systems:** Harnessing energy, even renewable energy such as light, sound or movement, requires the use of resources from the Earth. **World view:** We are respectful of the Earth's resources when we use energy. **Futures:** We care for our planet and other living things by conserving energy: turning off lights, drying our clothes in the sun, walking instead of going in the car, and thinking carefully about when we use machines to help us.
SCIENCE AS HUMAN ENDEAVOUR	*Scientists observe and collect data on changes in the environment, including changes in our weather patterns (ACSHE021).* They help us to understand what is happening, and find ways to slow down changes that are undesirable. *People use science in their daily lives to care for their environment and living things (ACSHE022).*	

Years 3-4

Prior learning

In the early years of schooling, students have developed an emotional attachment to nature and Earth, providing early motivation for caring for the planet. They bring to Year 3 an awareness that all living things have needs for survival, and that humans have responsibilities in caring for the environment and living things. They are aware of, and pay attention to the weather: to what is happening about them in the atmosphere each day, and how living things adapt and respond to weather.

Climate change science learning in Years 3-4

In Year 3, students observe heat and its effects on solids and liquids and begin to develop an understanding of energy flows through simple systems. They understand that a change in temperature can cause some solids to melt, or liquids to freeze, and apply this information to their understanding of water systems including oceans, glaciers, and fresh water. In studying changes in states of matter from solid to liquid, they begin to understand the effect of increased temperatures on land ice in the Antarctic and Greenland, and the effect on sea levels.

By observing day and night, they develop an appreciation of regular and predictable cycles, and understand that the Earth is a rotating sphere that gets energy from the sun. Students begin to classify things as living or non-living.

In Year 4, students broaden their understanding of the properties of natural and processed materials, and discuss ways of taking action to conserve materials and energy by using materials sustainably, including reducing, re-using, and recycling. They begin to appreciate that current systems, such as the Earth's surface, have characteristics that have resulted from past changes and that living things form part of systems which can operate at different time and geographic scales. They learn that some of Earth's resources, such as coal and oil, have taken millions of years to form, have been formed from things that were once alive, and are not easily or quickly replaced. They think about the possible effects of human action in the use of resources and why we need to act sustainably.

Language learning in Years 3-4

In these years of schooling, students begin to hear and understand scientific terminology, as they are apprenticed into the world of science. They describe and explain with more authority the phenomena they observe, and begin to argue for actions to support sustainability. As they gain more control over English orthography, they begin to write information reports and explanations more independently, as well as gain experience in formal oral presentations. In English, they are learning how to persuade, and can use these new language resources to convince parents and family members to be sustainable. Parents become an important audience for students as they begin to take on the scientific mantle, with growing attachment to the scientific community.

Taking action in Years 3-4

In Years 3-4, students continue their local advocacy. Sustainable practices such as re-using and recycling become more habitual. They begin to take a role in working with younger students, familiarising them with the school's sustainable processes. They might be involved in raising money for an environmental cause, and learn that working for a sustainable future takes effort.

YEARS 3-4 SCIENCE TOPICS FOR CLIMATE CHANGE

	Science content descriptions and elaborations	*Implications from the sustainability cross-curriculum priority*
BIOLOGICAL SCIENCES	*Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044)* -Understand the differences between living, once living and non-living things -Understand that we use the energy from things that were once alive *Living things have life cycles (ACSSU072).Understand that living things depend on each other and the environment to survive (ACSSU073)* -Understand that living things need healthy environments to thrive and reproduce.	**Systems:** All living things within a habitat are interdependent. The habitat includes non-living things. Changes that disrupt any part of the system affect us all. **World view:** We depend on the health of all living things in the biosphere to survive. Humans are just one among many living things that depend on each other for survival. **Futures:** We look after our local habitats to keep them liveable for all living things.
EARTH SCIENCES	*Earth's rotation on its axis causes regular changes, including night and day (ACSSU048)* -Understand that the Earth is a planet, and a rotating sphere *Earth's surface changes over time as a result of natural processes and human activity* (ACSSU075) -Understand that the Earth is made up of land, oceans, ice at the poles, and the atmosphere -Understand that humans change the Earth's surface for different purposes, e.g. farming, land clearing, mining, and urban development.	**Systems:** Climates around the globe are an interconnected system. Global warming impacts weather patterns across the whole globe. **World view:** We know that human actions have caused changes to the climate that need to be slowed down. Our actions help to do that. **Futures:** We conserve the Earth's resources, including materials and water, to help slow down climate change.
CHEMICAL SCIENCES	*A change of state between solid and liquid can be caused by adding or removing heat (ACSSU046)* -Understand that the melting of the ice shelves and the warming of the oceans both contribute to sea-level rise -Understand that the combustion of fossil fuels leads to carbon dioxide acting as a blanket around the Earth, trapping heat. N*atural and processed materials have a range of properties and sources that influence their use (ACSSU074)* - Understand that plastics are made from fossil fuels. They have useful properties but there are issues for the Earth with recycling and waste disposal.	**Systems:** Producing gases in our part of the atmosphere warms the ocean, and impacts the ice shelves, both of which cause sea-level rise. **World view:** We know that our actions impact on other living things, and we are careful, not careless, about how we use materials, including plastics. **Futures:** First we reduce our use of materials, then we re-use, recycle, and repurpose as much as we can before sending them off to landfill.

PHYSICAL SCIENCES	*Heat can be produced in many ways and can move from one object to another (ACSSU049)* -Understand that the sun gives us energy, including heat and light -Understand that insulating an object can slow heat transfer, eg trapping heat inside a container and reducing the amount of energy used -Understand the effect of greenhouse gases which trap heat in the atmosphere.	**Systems:** The Earth's heating and cooling system which keeps the planet in a habitable temperature range is changing because of greenhouse gases. **World view:** Our local actions, such as reducing our energy use and being careful about our use of resources, matters for our future. **Futures:** We reduce our use of fossil fuels so that less heat is trapped and we do this by using alternative energy sources that don't produce greenhouse gases.
SCIENCE AS HUMAN ENDEAVOUR	*Science involves making predictions and describing patterns and relationships (ACSHE061).* This is how scientists have observed and predicted climate change and use modelling to forecast future scenarios *Science knowledge helps people to understand the effect of their actions (ACSHE050)* Science can help us to manage our resources more sustainably, reduce waste, and help maintain healthy environments and ecosystems.	

Years 5-6

Prior learning

In the early years of schooling, students began by developing a positive emotional attachment to nature, living and non-living things, and learned how each living thing has a particular environment in which it survives and thrives. By now, they understand the symbiotic relationship between animals and plants, and the planet itself, and how we need each other to continue to thrive.

Students are beginning to understand the causes of the warming planet, and the effect of heating on sea levels and extreme weather. They are also taking more responsibility for their own actions and the positive or negative effect these actions have on sustainability. They have begun to describe and explain phenomena using some technical scientific terminology, aligning themselves with the world of scientists, and understanding that we have to listen to scientists and act on their advice if we are to slow down climate change.

Climate change science learning in Years 5-6

Years 5-6 are a pivot point in science learning. If the work in previous years has been thorough, and has included the development of scientific language, students in Years 5 and 6 can use both language and activity to strengthen, consolidate and develop scientific concepts.

In biological sciences, students learn more about the importance of the environment to living things, and the impact when environments are suddenly or gradually changed. They develop from recognising physical characteristics and observable behaviours, to understanding the time scale of adaptation, and how it has led to each living thing finding a habitat where it can survive. Significantly, climate change can change habitats more quickly than adaptation can catch up.

In chemical sciences, the work on materials focuses on plastics and metals: the impact on the environment as we dig oil and minerals out of the ground; the fact that they are non-renewable; and the consequences of that fact for land fill, pollution and oceans. Contemporary humans cannot live without these resources, but all human beings, including young citizens, need to learn how to use them judiciously.

Earlier work on states of matter reinforce the significance of a heating planet on oceans and the polar regions, and in turn, the effect of rising sea levels, melting ice shelves and glaciers on coastal communities. Students return to earlier learning about weather and climate to look at the effects of climate change on extreme weather, and the impact on living and non-living things.

Language learning in Years 5-6

Students are able to describe and explain using scientific terminology. They continue to strengthen their skills in arguing for action, drawing on their scientific knowledge. They become more familiar with text structures and grammar resources of significant scientific text types and begin to understand the purpose of these grammatical structures. They begin to use data to backup arguments.

Taking action in Years 5-6

In Years 5-6, sustainable practices such as reusing and recycling become more habitual. Students take a role in working with younger students, familiarising them with the school's sustainable processes, and explaining in simple terms why we do it. Their advocacy extends beyond the school boundaries to the local council area, shopping centres and local government. They visit local sites to see the effect of climate change, and to understand how science is helping to mitigate it. They begin communication with students in other parts of the world who are also advocating for the Earth.

YEARS 5-6 SCIENCE TOPICS FOR CLIMATE CHANGE

	Science content descriptions and elaborations	*Implications from the sustainability cross-curriculum priority*
BIOLOGICAL SCIENCES	*The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094)* -investigate what happens when habitats change, and some living things can no longer have their needs met e.g. the effect of long-term drought and wildfires on living things *Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)* -understand the physical and behavioural adaptations of animals and plants that make them suited to the climatic and physical conditions of the environment they inhabit -understand what happens when changes in climate move faster than the ability of the living thing to adapt.	**Systems:** Ecological systems have always changed, but at a pace where living things can adapt. Human induced climate change is moving so fast that living things are struggling to adapt. **World view:** We know that climate change is threatening the Earth's natural systems, and we know that we can help. **Futures:** We think about our own actions so that they help to mitigate climate change and we turn them into habits. We act locally to influence others.
CHEMICAL SCIENCES	*Solids, liquids and gases have different observable properties and behave in different ways (ACSSU077)* -Understand that fossil fuels can have different states: solid (coal), liquid (oil) and natural gas -Understand that that their states mean they are stored in different ways, but when fossil fuels are burnt to make energy for our many purposes, they all produce greenhouse gases -Understand the properties and behaviour of greenhouse gases: carbon dioxide, methane, nitrous oxide and water vapour -Understand why the burning of fossil fuels and the greenhouse effect is contributing to the warming of the planet. *Changes to materials can be reversible or irreversible (ACSSU095)* -Investigate the recycling of materials: how they can be changed and reused.	**Systems:** Global production to meet human needs produces greenhouse gases that affect all countries, whether they are big polluters or not. **World view:** Reducing our dependence on fossil fuels is the best way to reduce greenhouse gases. We have an impact on the use of fossil fuels through the way we use the Earth's resource. **Futures:** We use fossil fuels less, and alternative energy sources such as solar, and wind more. We reduce energy use where we can: the easiest way for us to do that is by thoughtful use of resources: walk more, consume less, buy local, have shorter showers; turn these practices into habits.

EARTH SCIENCES	*Sudden geological changes and extreme weather events can affect Earth's surface (ACSSU096)* -Understand the difference between climate and weather -Understand how climate change will affect extreme weather events such as floods, cyclones and drought	**Systems:** The Earth's system of heat management that keeps the atmosphere in a habitable range is under stress. **World view:** We have a responsibility to do our part in mitigating climate change, and in thinking about how to adapt and to support other living things. **Futures:** We develop local systems for managing extreme weather that support humans and other living things. Our actions at home, school and in the local community work to mitigate the extreme effects of climate change.
PHYISICAL SCIENCES	*Light from a source forms shadows and can be absorbed, reflected, and refracted* (ACSSU080) -exploring objects and devices that include parts that involve the reflection, absorption, or refraction of light (ACSHE083) - albedo effect: the cooling effect on the planet of ice on the poles, and what happens to light reflection and absorption on dark and light surfaces	**Systems:** The reflection of radiation by ice at the poles is part of the Earth's cooling system. When ice melts less radiation is reflected, and the system is disrupted. **World view:** Even though we are far away from the poles, our actions impact on them. **Futures:** As for Chemical Sciences above.
SCIENCE AS HUMAN ENDEAVOUR	*Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)* *Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena (SCSHE081)* e.g. atmospheric Cox readings since 1958 *Important contributions to the advancement of science have been made by people from a range of cultures (ACSHE082)*	

YEARS 7-8

Prior learning

To this point, students bring their respect for the planet to an emerging understanding of the system of living things, of states of matter and climate. They are able to describe parts of the natural environment, explain phenomena increasingly authoritatively, and take part with an understanding of the scientific process in scientific investigations and explorations.

Climate change science learning in Years 7-8

Years 7-8 display a significant shift in the detail and depth of scientific understanding. Their understanding of climate change is clarified, as they focus on systems and disruption to systems. In Year 7, through their study of food chains and the food web, students understand the flow of energy and matter that happens across ecosystems, and what happens if these energy chains are disrupted because of disruption to habitats.

Importantly, they explore the notion of renewable and non-renewable resources and consider how this classification depends on the timescale considered. They now begin to understand how energy works as a closed system, why our overuse of fossil fuels is leading to the heating of the planet, and how sustainable alternatives (e.g. solar, wind, tide and geothermal) to the production of energy can help to mitigate climate change.

In Year 8, students begin to classify different forms of energy, and describe the role of energy in causing change in systems, including the role of heat and kinetic energy.

Taking action in Years 7-8

By Years 7-8, students have a depth of understanding about the causes of human-induced climate change that allow them to debate convincingly. They use this knowledge to expand their sphere of influence. They take leadership in their school, working with students, staff and the governing council to audit and reduce energy use through resource procurement, re-use of materials and rubbish disposal. They advocate for and support changes from peers, the local community, local businesses and local council. Their voices are shared with our political leaders.

Language learning in Years 7-8

With all this understanding comes the need for language development. Students are not only able to use technical language, i.e. power up, but they are also able to define these powerful terms in everyday language i.e. power down. They have control of the structure of useful scientific genres and macro-genres, and understand the different purposes of these texts. They are explicitly taught how to structure arguments and persuasive texts, written and oral, taking into consideration different audiences and their needs. Their formal oral presentations can move from isolated events to participating in formal debates.

Importantly, across these two years, students take control of the logical unfolding of texts, through word chains, and linking conjunctions. They are introduced to the ‘given-new’ pattern across explanations and arguments. This requires understanding and control of passive voice, and nominalisations. These are complex grammars, and rely on prior knowledge of many aspects of grammar which have been previously taught.

YEARS 7-8 SCIENCE TOPICS FOR CLIMATE CHANGE

	Science content descriptions and elaborations	*Implications from the sustainability cross-curriculum priority*
BOLOGICAL SCIENCES	*Interactions between organisms can be described in terms of food chains: human activity can affect these interactions (ACSSU112)* -Understand the transfer of energy and matter in food chains and webs. -Understand how one change can disrupt the whole system and the impact on that ecosystem.	**Systems:** Food chains are systems. If any part of the food chain is disrupted because of changes to the environment, these changes affect all parts of the food chain. **World view:** Disrupted food chains have the greatest impact on the most vulnerable living things, including people. Looking after our community means helping out. **Futures:** We act locally to help maintain food systems. We advocate for energy and food supply systems that are sustainable into the future. We are mindful of the sustainability of our own food chain systems.
PHYSICAL SICENCES	*Energy appears in different forms including movement (kinetic energy), heat and potential energy, and energy transformation and transfers cause changes within systems* (ACSSU155) -Understand how energy is transformed in generating power using fossil fuels and renewable energy sources	**Systems:** Earth's energy is a closed system. It cannot be destroyed. Left alone, the Earth's energy has been relatively stable for the past 800,000 years. The use of fossil fuels as an energy source has disrupted the system, releasing additional greenhouse gases which trap heat and lead to climate change. **World view:** Human generation of greenhouse gases is the major contributor to the warming of the Earth. We work on solving this problem together. **Futures:** Knowledge is the first step. We act through our mindful use of resources, by influencing our community, by caring for local habitats, by advocating with our local governments
EARTH SCIENCES	*Some of the Earth's resources are renewable, but others are non-renewable* (ACSSU1116) -Understand the difference between renewable and non-renewable energy sources according to time scales	**Systems:** When non-renewable resources, i.e. coal, gas and oil have been used up, the current energy supply system will have to be replaced. **World view:** We can continue to supply the energy we need with new renewable systems. **Futures:** We continue to develop ways of using renewable energy e.g. solar, wind, tide and geothermal. We understand how our choices in resource use impact on available resources in the future. We act to manage our own resource use and influence others.

CHEMICAL SCIENCES	*Chemical change involves substances reacting to form new substances (ACSSU225)* -Understand how cattle and micro-organisms convert organic material into methane -Understand the sources of greenhouse gases, and why they are increasing. *The properties of states of matter can be explained in terms of the motion and arrangement of particles (ACSSU151)* -Understand why increased greenhouse gases are so harmful -understand why sea levels are rising.	**Systems:** Carbon is everywhere. Earth has a system for storing it, sequestered in soil as a chemical substance in organic material. When it is burnt a chemical reaction releases carbon dioxide as a gas. When frozen soils in the permafrost thaw, microbes turn the carbon into carbon dioxide and methane, releasing it into the atmosphere. **World view:** We can slow down global warming through our use of renewable energy sources. **Futures:** We have to reduce the amount of carbon dioxide and methane that we release into the atmosphere and find ways of sequestering carbon. This is the responsibility of us all, from individuals, to local councils, industry and countries.
SCIENCE AS HUMAN ENDEAVOUR	*Scientific knowledge changes as new evidence becomes available. Some scientific discoveries have significantly changed people's understanding of the world (ACSHE119)* *Science and technology contribute to finding solutions to a range of contemporary issues (ACSHE120)* *Science understanding influences the development of practices in, for example, industry, agriculture, and marine and terrestrial resource management (ACSHE136).* *Science and technology contribute to finding solutions to a range of contemporary issues (ACSHE135)*	

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