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What can we do to protect our coral reefs from climate change?

Effects of Climate Change on Coral Bleaching

Teacher Introduction

This unit of work is designed for middle year students. It has a student learning focus and anticipates that you the teacher will coordinate your students' learning and there is little need for instruction.

The activities require students to use the accompanying webpages. These pages have been developed using the following criteria:

- Designed to engage students who are reluctant to read. Each page is kept to less than 200 words.
- A core set of potentially new key words are introduced to students. There are not too many new technical words for your students to remember.
- The pages have an appropriate literacy design with a suitably sized text, the illustrations support the text and there are no gimmicks.
- The website is designed to be handled by school networks.
- Your students are provided with recommended websites for those who are motivated to go deeper.

The topic will enable your students to learn at a deeper level. They will make many links in their understandings and insights. They will learn and discover links between the following:

- Biology of a coral polyp.
- Biodiversity of a coral reef.
- Influence of greenhouse gases on climate.
- Current and future impact of climate change on coral reefs.
- What others are doing to reduce the production of greenhouse gases.
- What we can do to reduce the production of greenhouse gases.



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1. Classroom Preparation

How can your classroom be organised to provide a stimulating learning environment about coral reefs? Will you want to set up the class before your students start the unit? Some ideas could include:

- Locate posters and place them on walls.
- Make sure you have access to computers that are connected to the Internet.
- Find out what resources are available in the library. Will you borrow some of these books?
- Locate videos, DVD's and CD ROMs.
- As a prior learning activity, each student could contribute a reef animal to a large collage or ceiling hanging.
- Load a marine screen saver onto computer screens.
- Where will students work be displayed?
- Ask your students to contribute ideas to a classroom setup.



2. Activities – Prior learning

Materials: Art and craft materials, colour pencils, A4 paper

Background: Prior learning activities enable students to value what they already know about a topic. It provides their teacher with some insight into what their students know and think.

Activities: Choose one or more of the following activities or provide an activity of your own. Ideas for prior learning:

1. Using art and craft materials, ask each student to make an animal that they think might be encountered on a coral reef. Their work could be suspended from the ceiling. As the unit develops, students could add to their coral reef, making it more representative of a true coral reef.
2. Ask students to use their colour pencils and an A4 page to make a freehand drawing of a coral reef. Provide students with a time limit e.g. 5 minutes. Then ask them to explain their illustrations to at least two other students.
3. Ask students to write in dot-point form, what they would expect to do if visiting the Great Barrier Reef. As a class share their ideas and past experiences.





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3. Student Goals and Assessment

Materials: Copy of "Student goal setting" activity sheet

Goals background: Goals assist students to be more involved in self-directed learning, to remain on track and meet their learning objectives.

Activity: Student goals can be developed using the following three areas:

1. Goals developed from the above authentic learning question "What can we do to protect our coral reefs from climate change?" The goals can include:
 - Understand why coral reefs are under threat from climate change
 - Describe the process involved in global warming
 - Explain how individuals including themselves and groups are able to reduce their contribution to greenhouse emissions
 - Communicate to others how they can reduce the impact of climate change on Australia's and the world's coral reefs.
2. Goals can relate to the Learning Outcomes or Standards you will be assessing during this unit of work.
3. Individualised student goals can be identified. These will improve their specific learning needs. For example each student reflects on their last unit of work and identifies two aspects where their learning can or should be improved.





3. Student Goals and Assessment - Continued

Assessment background: Education systems have greater expectations concerning assessment. Having assessment processes in place throughout a unit of work and involving students in their assessment will assist teachers meet these expectations:

- Assessment for learning will help teachers respond to students' learning needs during the unit of work.
- Assessment as learning occurs when students monitor their own progress and make learning choices.
- Assessment of learning occurs when teachers use evidence of what students have achieved. Teachers often must measure this against Learning Outcomes or Standards.

Explain to students how they will be assessed. To assist you with assessing your students throughout the unit of work:

- A grid of suggested assessment tasks has been provided.
- A rubric that you may wish to modify has been developed.

Theme

Examples of assessment tasks

Activities – Prior learning	<ul style="list-style-type: none"> • Participation and contribution to a class activity. • A well considered input relating to their prior knowledge
Student goals and assessment	<ul style="list-style-type: none"> • Able to record the required goals for the unit of work. • Shows an understanding of their personal learning needs by setting personal learning goals.
Group activities – Life, life everywhere – Biodiversity on a coral reef	<ul style="list-style-type: none"> • Organising work in a team. • Working cooperatively with others. • The team takes control of the research. • Sharing information. • Working independently. • Completing tasks on time. • Using different sources to obtain information and solve problems. • Effectively using technology to obtain information. • Providing evidence of how and where they found information. • Extracting and making notes of the appropriate information to answer their questions. • Present ideas and information using a range of formats and media. • Appropriate use of media in preparing a report. • Presentation demonstrates that students answered their questions.
Group activities – Feeling sensitive?	
Group activities – Finding evidence for climate change	



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3. Student Goals and Assessment - Continued

Theme

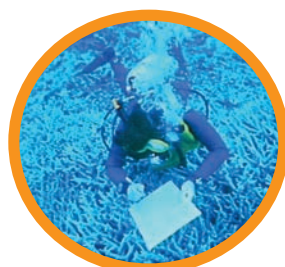
Where can we start reducing greenhouse gases?

Examples of assessment tasks

- Organising work in a team. Working cooperatively with others.
- Effectively uses technology to solve problems.
- Able to express personal views while respecting the views of others.
- Able to weigh up a number of options.
- Use creative strategies to solve problems and prepared to take learning risks.
- Completes the task to develop a new chain on time.
- Shows an understanding of how people's activities link to global change
- Presentation of their solutions.

Communication project

- The content of the communication product demonstrates their understanding of the unit of work.
- An appropriate media has been chosen and justified for a specific audience.
- The communication package is engaging to the chosen audience.
- The media has been used in an appropriate way.
- The communication product demonstrates creativity.





4. Group Activities - Getting to know your corals

Materials and equipment: Access to the Internet, copies of “Getting to know you” activity sheet, writing materials, plasticine or play-dough.

Background: Students will research aspects of the biology of coral polyps, their symbiotic relationship with a special algae and their ability to lay down coral reefs. Students will then take on a challenge that will take them deeper into characteristics of corals.

Activity 1: Research into coral

Students should start their research with the AUSMEPA website www.ausmepe.org.au and locate the webpages on corals. Some students will want to go further, however it is difficult to locate information that describes the biology of coral polyps. As a class ask them what they may need to find out about how corals grow and creates coral reefs. These are some of the questions that could be asked:

- What is a coral polyp, what size is it, where does it live?
- What features does a coral polyp have? What features don't they have?
- How do corals get their food?
- How do stinging cells work?
- How does a coral polyp digest food when it does not have an anus?
- What is a symbiotic relationship? What is the relationship with coral polyps and zooxanthellae?
- What is the hard white material that makes up a coral reef? Why does the coral polyp produce this material?
- How big are coral reefs?

Students should record the questions along with the information they found. If you are assessing their skills at using computer technology, you may want to ask them to explain how they located the information to answer the questions.

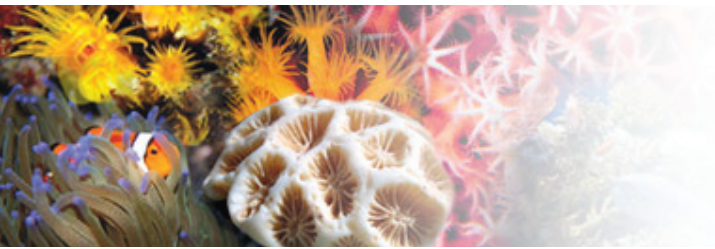
Activity 2: Getting to know you

Ask students to complete the “Getting to know you” activity sheet. Have a class about how coral polyps survive.

Activity 3: Coral challenges

This activity allows students to apply their knowledge about coral reefs. Students can create their own challenge, but must first explain it to you to make sure it is safe or choose one of the following:

- Using plasticine or play-dough to make an accurate model (including size) of a coral polyp.
- Using plasticine or play-dough to make a cutaway model of a coral polyp showing its internal structure. Make the model larger than real life.
- Use a carrot or potato to make a coral skeleton stamp. Use a compass to scratch an impression into the vegetable that is equivalent to the base of the coral polyp. Press the stamp into plasticine or play-dough. Can they make the plasticine or play-dough look like a lump of coral?
- Use plasticine or play-dough to make a variety of common shapes seen on coral reefs.
- Examine a variety of different corals using images on the Internet. Describe what features could be used to classify different species of coral.



5. Group Activities

- Life, life everywhere - Biodiversity on a coral reef

Materials and equipment: Access to the Internet, copies of "Complete the reef" activity sheet

Background: One of the simplest animals is responsible for one of the most intricate ecosystems. It will take hundreds of years for researchers to investigate all the relationships between different species. What we aim for in this section is for students to develop some comprehension of species diversity and ecosystems diversity.

Activity 1: Research into the biodiversity of a coral reef

Students should start their research with the AUSMEPA website www.ausmepe.org.au and locate the webpages on corals. Students will find many other websites of interest. As a class ask them what they may need to find out about the biodiversity of coral reefs. These are some of the questions that could be asked:

- What is meant by the biodiversity? How can species diversity be explained. What kind of ecosystem diversity is found on coral reefs?
- How diverse are the fish on a coral reef?
- How diverse are invertebrates on a coral reef?
- How diverse are corals on a coral reef?
- What would happen to most of the marine life if there was no coral reef?
- How different are the many species of fish? How much difference is there in the way they live?
- Do sharks play an important role on the Great Barrier Reef?
- Are there any dangers to people on the Great Barrier Reef?
- Are all reefs the same? How can reefs be classified?

Students should record the questions along with the information they found. If you are assessing their skills at using computer technology, you may want to ask them to explain how they located the information to answer the questions.

Activity 2: Complete the reef

This can be a quick or slow activity. As a quick activity, students write the names of animals they could expect to find in appropriate locations on the illustration. Alternatively, they could spend more time on the activity by accurately drawing animals and colouring in the scene. They could use images from the Internet and books to try and portray the scene with accurate colours.





5. Group Activities - Biodiversity on a coral reef - Continued

Activity 3: Ecosystem diversity challenge

Is there any way for students to describe ecosystem diversity among coral reefs? Expect students to find this activity very challenging. You may wish to provide a time limit and discuss why they had difficulties with some of the challenges. Students can formulate their own challenge or choose one of the challenges below. Google Earth might be slow on your school system, so students may prefer to use their home system.

- Is there any way to describe some of the major types of reefs, inner reef, outer reef and reefs around islands?
- Is Google Earth of any use in describing ecosystem diversity of coral reefs?
- Why do tour operators go to the outer reef? Is the reef experience around an island e.g. Green Island, or Magnetic Island any different?
- Is anyone on the Internet describing ecosystem diversity of coral reefs?
- Is there any information about the difference between coral reefs in different seas? Where are the top coral reef diving locations around the world?
- Does ecosystem diversity change as the reefs move away from the equator?





6. Group Activities - Feeling Sensitive?

Materials and equipment: Access to the Internet, copies of "Coral polyps are super picky."

Background: Coral polyps and their zooxanthellae require very special environments and can be very sensitive to many human activities. It is possible that the world's coral reefs are a major global environmental indicator of the impact people are having on the planet.

Activity 1: Coral polyps are super picky!

Make copies of the activity sheet, "Coral polyps are super picky." Students use the Internet and other resources to research how the following conditions impacts on the survival and growth of large coral reefs:

- Depth of water
- Nutrients in water
- How clear does the water needs to be, the impact of sediments washed in from the land
- How close to the equator they need to be to survive
- Impact of cyclones
- Temperature range for different locations
- The impact of seawater becoming more acidic
- Does fishing have an impact?
- What is the problem with the Crown-of-thorns sea stars?

Activity 2: Death by temperature increase

Ask your students to find out about coral bleaching. Their task is to make a diagram of the sequence of events that leads to the death of coral polyps. The student directions are:

- They will make a diagram
- Their diagram will show each step in a sequence of events
- The diagram is about how coral polyps die in an event called coral bleaching
- The diagram is over a period of time and shows the cause of the bleaching and how long this cause lasts to have a devastating impact.

Students who want some extension on this activity can include recovery of reefs after coral bleaching and other environmental issues that can prevent some reefs from recovering.

Compare different diagrams and discuss their common elements. Which of their diagrams best explain how coral reefs become bleached and die?





7. Group Activities - Finding Evidence for Climate Change

Materials and equipment: Access to the Internet

Background: The purpose of these activities is for students to identify claims, find evidence that supports or contradicts these claims and be critical about the authenticity of evidence they find. They can then draw conclusions about how valid they believe the claims are.

Activity 1: What are the claims?

The overall claim is that: “climate change is causing coral bleaching.” This claim can be broken into smaller claims. In activity 4 students will search for evidence. As a class try and list a range of claims. These will include:

1. Some gases like carbon dioxide and methane that occur in the atmosphere hold more heat than oxygen and nitrogen and increase the temperature of the Earth’s climate.
2. The quantity of greenhouse gases in the atmosphere are increasing.
3. The increase in greenhouse gases is being caused by the activity of people.
4. The amount of greenhouse gases being produced is accelerating.
5. Natural cycles on the Earth can only absorb a fraction of the greenhouse gases produced.
6. Greenhouse gases will eventually lead to large scale climate change.
7. Greenhouse gases will eventually lead to modest climate change.
8. Changes in climate have already started and have been observed by higher sea temperature.
9. Higher sea temperature cause coral bleaching.
10. Coral bleaching will cause the destruction of coral ecosystems.

Keep this list of claims for activity 4

Activity 2: How can some extra gases increase the temperature in the air?



Ask students to work in small groups. Each group is to make a presentation to explain how greenhouse gases can increase the temperature of the air. Each group will decide what media they will use for their presentation and present it to the class. At the end of each presentation make a list of what students learnt from the presentation. This could consist of a grid on the black board adding to the list and having ticks for each group. At the conclusion of the presentations, summarise the points students communicated accurately and dispel any myths or incorrect concepts that arose.

Activity 3: Authorities and experts

Use the activity sheet “Authorities and Experts.” In activity 4, students are asked what expertise the person or group has who are providing evidence for a claim. Do this activity if you feel that your students need to clarify what is meant by an expert. This activity goes from everyday school situations to areas of science and asks students to choose those who have authority (could be more than one) and those who are the best expert (only one choice). Later you may wish to look at how people in authority may need to fix a problem in the environment, but it is specific experts who know what needs to be done.



7. Group Activities - Finding Evidence for Climate Change - Continued

Activity 4: What evidence is there supporting these claims?

Your students in Activity 1 made a list of claims about climate change and coral bleaching. Divide the list of claims among your students. They will be using the Internet to find what evidence there is to support or refute the claims. They need to also deduce what qualifications or expertise the provider of the information has for making the claims. Students could set out their work in the following way:

Claim _____

Evidence supporting claim

Qualifications, expertise of those providing evidence

Etc.

Evidence not supporting claim

Qualifications, expertise of those providing evidence

Etc.

Activity 5: What do we know about climate change?

New information is coming in every day about the potential impact of climate change. There are some things the experts are confident about e.g. increase greenhouse gases will eventually result in climate change. There are other areas where scientists do not have enough understanding to make good predictions e.g. it is still impossible to predict how big the climate changes will be. However even the smallest predictions will potentially devastate coral reefs. As a class, go through what they have learnt about the claims. Make a list of what they believe is certain and what cannot be supported from current evidence. Students may like to suggest what further evidence is necessary.





8. Bringing it Together

As a class, use these different ways of thinking to explore and expand what students have learnt.

What students know -

What do you know about the greenhouse affect?

What do you know about coral reef ecosystems?

What do you know about the impact of abnormally high seawater temperature on coral reefs?

How students feel – How do you feel about the Great Barrier Reef and other coral reefs?

Do you feel that coral reefs are being adequately protected? What do we like about coral reefs?

Students are critical thinkers – How difficult is it to stop climate change?

Why aren't people doing more to prevent climate change?

What are some risks to coral reefs from climate change?

Students find the benefits –How are coral reefs important to people?

How will preventing climate change help people? How will preventing climate change help coral reefs?

Students are creative, find solutions and make recommendations – How can new technology help reduce greenhouse gas emissions?

How can we live more sustainably and produce less greenhouse gases?

How can we influence others to reduce greenhouse emissions?

What can governments do?

Where do students go from here?

How has your way of thinking about coral reefs changed?

How has your thinking about climate change changed?

What can you recommend to reduce greenhouse gas emissions?





9. Shipping - Major users of the Oceans

Materials: Access to the Internet, and library

Background: Shipping has been used to transport goods over great distances for thousands of years and remains a major user of the oceans. While shipping disasters through time have often had a devastating impact on local environments, modern technology and safe practices on board have dramatically increased safety and significantly reduced the shipping industry's impact on the ocean environment

Activity 1: Disaster on the high seas

In this activity students have 15 minutes to locate information about shipping disasters. They can use the Internet or the school library. Divide the class up for different time periods:

- Last 10 years
- Second half of the 20th century
- First half of the 20th century
- Nineteenth century around Australia's coast
- Nineteenth century elsewhere in the world
- 1000 AD to 1800 AD
- 0 AD to 1000 AD
- BC

Give each group a minute to present their information.

Activity 2: Technology and safe practices on the high seas

Discuss some reasons why ships throughout history have been involved in disasters. In what ways have ships improved in safety? Divide students in groups. Examine how safe practices and technologies in these areas are helping ships avoid accidents and minimise their impact on the environment:

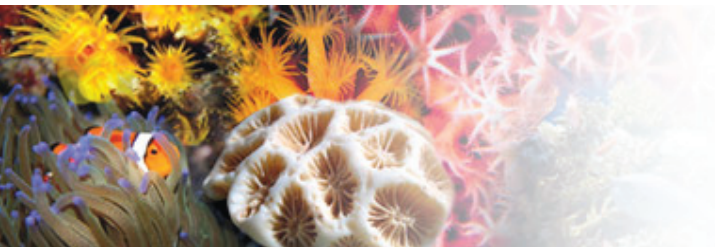
- Navigation including the use of GPS
- Sonar/Echo Sounder
- Communications
- Weather forecasting
- Ship design

Activity 3: Energy efficiency and transport alternatives

Large volumes of goods are transported around Australia. Analyse how each form of transport impacts on the environment? Compare the impact of road, rail and shipping transport. How do they compare for:

- Production of greenhouse gases
- Other pollution
- Safety
- Building and maintenance of required infrastructure
 - o Trucks need roads
 - o Trains need rails
 - o Ships need ports





10. Where can we start reducing greenhouse gases?

Materials: Writing materials. And copies of “How I feel” and “How good are the options” activity sheets.

Background: Throughout the lives of your students, the debate concerning what people and governments should do about climate change will continue. We are constantly told new technology such as solar energy will save the day. However science magazines were saying that a new breakthrough on solar cell technology was just around the corner back in the 1960s when I was a middle years student. As well as changes in climate, the economic and technological consequences will affect the futures of your students.

Activity 1: How I feel

Ask students to fill in the “How I feel” activity sheet. They mark on a continuum how strongly they feel about particular statements about the impact of climate change. When the class has completed the activity sheet:

1. Ask students to individually choose the four statements they most strongly feel about.
2. Then go through the statements and find the four which the class collectively feels most strongly about.

Activity 2: What are our options?

Brainstorm and use the Internet to make a list of options that people can use to respond to the prospect of climate change: The list should include:

- Live with the problem. Some people may even get advantages from climate change.
- Use less energy. Have an education program so people are less wasteful.
- Use less energy. Gradually replace all our machines and electrical goods with more energy efficient products.
- Use less energy by charging people at least three times more for electricity and fuel.
- Use wind energy by building more wind farms.
- Use wave energy along the coasts of Australia.
- Use solar energy (will need to charge people a lot more because it is more expensive to produce).
- Produce nuclear energy (it will take at least 15 years to build and start operating a nuclear power plant).
- Develop better transport systems and policies e.g. more people on public transport, use more shipping.
- Grow more trees to absorb the carbon dioxide.
- Use new technologies to capture carbon dioxide and store it under the ground (and hope it does not escape).





10. Where can we start reducing greenhouse gases? - Continued

Activity 3: Research how good the options are

Divide the most worthwhile and controversial options to individual students. It would be good if each option was done several times as it would provide a range of points of view. Use the “How good are the options?” activity sheet. Some options will require research while others require logical and compelling arguments. Each option should be thoroughly documented.

Activity 4: Debate and prioritise

Each option is written on a sticky note so it can be attached to a board. On the board there are four boxes:

- Box 1 – option has highest priority.
- Box 2 – option really good.
- Box 3 – good option, but others are better especially when there is a shortage of money.
- Box 4 – no way, option goes to the bin.

Each option is debated and student vote in which box it should go. Explain that at the end there should be approximately the same number of options in boxes 1, 2 and 3. Box 4, the reject box has no limit on numbers

Activity 5: Our country's response to climate change

Your class is to develop an Australian policy to climate change. Ask students how they would like to achieve this. They could:

- Do it as a class.
- Produce separate policies in their small groups.
- Divide the policy into sections, and each group does a section.

Students may be motivated to send their class climate change policy to their local member of parliament.





11. Making a Pledge

Materials: Writing materials, art paper and scissors

Background: Making a pledge provides people with an opportunity to affirm their beliefs and explains what it is they want to do.

Activity 1: Pledges

Students will make three postcard size cards. They can colour them in if they wish. They could be designed on a computer. Each postcard will have on it the following:

- My personal pledge for reducing the impact of climate change
- What my family could do to reduce the impact of climate change
- What my school could do to reduce the impact of climate change

If students wish, they can give the family postcard to a member of their family and the school postcard to a person with authority in their school.





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12. Communication Project

Materials: Access to a wide variety of media, "PMI assessment" activity sheet

Background: Communication projects enable students to apply their knowledge and the personal values they have developed. With this activity, a lot of additional learning occurs in groups. Alternatively, many of your students may wish to focus on their own to complete a project.

Activity 1: Choosing an audience

Students will be developing a communication product for an audience. The communication product explains to an audience something they can do to reduce their contribution to greenhouse gases. Students will need to:

1. Choose an audience e.g.
 - a. Other students
 - b. School administration
 - c. Families'
 - d. Council workers
 - e. Car drivers
 - f. Shoppers etc
 - g. People in authority
 - h. etc.
2. Identify the main interests of their audience.
3. Identify the kind of media their audience encounters each day.

Activity 2: Analysing their audience

Ask student to analyse their audience by:

1. Linking the interest of their audience to the message they wish to communicate.
2. Identifying appropriate media that link the message and the interest of their audience (the media are often restricted by the budget available). Communication products can include:
 - a. Posters
 - b. Billboards
 - c. Radio commercials
 - d. TV commercials
 - e. Newspaper advertisements
 - f. Press releases
 - g. Musical jingles
 - h. PowerPoint presentations
 - i. Webpage
 - j. Newsletter
 - k. Email letter
 - l. Competition





12. Communication Project - continued

Activity 3: Develop the communication product

Allow groups or individuals to design and develop their communication product. Students should write attached notes explaining how their product should work.

Activity 4: PMI student assessment

Use the “PMI” Activity sheet. PMI stands for plus – minus – interesting. In this activity a student looks at another student’s work and writes on the PMI Activity sheet what they think the pluses and minuses are and what they found interesting. Ask students to complete a PMI so that each piece of work has at least two or more assessments. The PMI assessment should not be written on the other students’ work.





12. Reflection

Materials: Reflection activity sheet

Background: Reflection time provides students with an opportunity to value what they have learnt and the learning processes they have been involved in.

Activity 1: Reflection activity sheet

Your students may have a preferred reflection strategy, so they should use these. The reflection activity sheet in this unit of work can be used to provide some structure while reflecting.

