**Maria James:** Hello, and welcome to this presentation to support the implementation of Unit three and four of the new study design for VCE Environmental Science. A special welcome to those of you who are teaching Units three and four for the first time. My name is Maria James, and I'm a VCAA Science Curriculum Manager. I'm very pleased today to focus on the content of Units three and four and to explore with you a few different possibilities in delivering the study design. We will look at the assessment options for units three and four, and examples of some student investigations that provide a snapshot of the course.

I would like to start by acknowledging the traditional custodians of the many lands across Victoria on which we are all living, learning and working from today. For myself, located at Fairhaven, I acknowledge the Eastern Maar peoples as the traditional custodians of the land. I would like to pay my respects to Elders past, present and emerging for they hold the memories, traditions, cultures, and hopes of all Aboriginal and Torres Strait Islander peoples across the nation, and hope they will walk with us on our journey.

The purpose of this presentation is to support you in delivering units three and four of the new study design. I'll explain the relationship between the key science skills and the key knowledge in the study design and discuss how you can apply the scientific methodologies through your selected practical activities, including field work. We will look at the content in unit three and four in some detail. I've included examples of contexts and resources that will help you in planning your teaching and assessment programme. I'll then show you how you can work with the new assessment tasks so that they are aligned with the VCE Assessment Principles. Unit three must be studied before unit four, but you can organise the areas of study in each unit in whatever way you choose.

Unit three is consuming biodiversity and environmental management, while the focus in unit four is on climate change and energy options. The unit four outcome three student design scientific investigation can be undertaken in either unit three or unit four or across both units three and four. But it is reported in this as part of unit four. The investigation involves the generation of primary data related to content in other units three and/or four so students will explore a scientific question of interest involving biodiversity, environmental management, climate change, or energy. In developing a unit three and four curriculum and assessment programme, we know that each school is different and its students have different strengths, talents, and resources. Therefore schools have flexibility in designing curriculum programmes to meet the needs of their cohort and to apply to the context in which students are learning.

No matter what programme you develop, there are two requirements that is, that your programme must align with the VCE Environmental Science design, and it must comply with VCE assessment principles. This planning template is used by schools that are new to delivering VCE, but it's also useful for all teachers in planning their teaching and assessment programmes. You can use the QR code to access the template for your own purposes. Whether you are a new or experienced teacher, you need to think about how you will integrate the key science skills into the key knowledge in developing your teaching and assessment programme.

The main changes in this new study design relate to the specification of eight scientific methodologies and reference to the use of Earth systems thinking and the application of sustainability principles in evaluating environmental science scenarios, case studies issues and challenges. As an example of integrating key knowledge and key science skills, I've used one of the new key science skills in the study design to show you that they are sometimes explicitly incorporated into the key knowledge. In this case, you can see that the sustainable principles listed in the key science skill is incorporated into the key knowledge in both units three and four. In most cases, the key science skill is generic and will apply across all areas of study.

This example relates to data analysis. Analysis and evaluation of data is an important skill for VCE Environmental Science students in order that they can develop justified conclusions and make recommendations in relation to environmental proposals. Data analysis is a feature of the assessment tasks as well. So you should ensure that you provide your students with a variety of examples of graphical representations of information and the time is allocated to discussing features such as graphs scales, and patterns or trends in data.

There are eight scientific methodologies relevant to VCE Environmental Science. The table shows some examples of how these may be applied. Further examples will be included in the online support materials. Planning your teaching and learning sequence should include opportunities for students to use these methodologies in their own investigations. You can see that some of these methodologies are not standalone. For example, the classification and identification task of using keys to identify invasive and non-invasive plant species could also form part of field work. A literature review may proceed as student's investigations, and modelling may incorporate the use of a controlled experiment. There has been a slight increase in the areas of character practical work as shown in the slide. You should note the practical work is not limited to laboratory experiments. You can check it at our online resources on the VCAA website for further examples of practical activities.

Field work is an important part of practical work in VCE Environmental Science, and it's one of the eight scientific methodologies relevant to the study design. Locations may be students own backyards or the school ground or local places of environmental interest. Five field work techniques are shown in the slide with examples for each of units three and four. Further examples will be provided in the online support materials. With an increased focus on stakeholder knowledge and values in the study design, questionnaires and interviews may become a more commonly used field work method.

Let's now look at the content. Unit three area of study one is about biodiversity. There are three aspects to this outcome. Students should be able to explain the importance of this biodiversity and how it has changed over time. They should analyse the threats to biodiversity, and they should evaluate management strategies in maintaining biodiversity in the context of one selected threatened endemic species. You can deliver this outcome in many different ways and in whichever way suits your situation. Students in your class may all study the same threatened species, or you could provide a choice. You could use a field trip to look at a local threatened endemic species. You could provide data and case studies about a number of different threatened species. Or you can give students a list of threatened species, including a short profile from which they select the species they'd like to investigate working individually or in groups. Biodiversity is studied in units seven to 10. It's a good idea to establish students pre-knowledge a provocation such as the one on the slide is one way to elicit what students already know about threats to biodiversity.

There are five key knowledge sections in unit three area of study one. The order of the key knowledge forms a logical sequence, but you have the flexibility to rearrange the content to suit your teaching programme. Whilst you may teach content outside the content specified in the key knowledge, you should be aware that only the key knowledge in this study design should be assessed. Of the third section related to assessment of changes in species diversity, Simpson's Index of Diversity has been nominated. There are a number of versions of Simpson's Index that can be used, the formula that we specified in the study design has been chosen because students will get a number between zero and one. The higher the value, the greater the diversity, which is relatively easy for students to understand. A suggestion for you here is that the calculator the students use in applying Simpsons Index to data used in class should be the same as the calculator that they take into their external examination so that they are familiar with the calculators functionality.

Mostly schools choose one selective threatened endemic species for all of the class of study, often associated with a field trip where students are involved in primary data recording. Historical data may also be collated so that students can explore how population numbers change over time and whether conclusions can be drawn about particular management strategies that have been tested. Field trip data are often used as the basis of an assessment task. There are three parts in the outcome for unit three area of study two relating to environmental management. While the effectiveness of a single case study must be evaluated, you may use other case studies to illustrate specific concepts related to sustainability and stakeholder perspectives to show commonalities across different projects. As one approach to introducing this area of study, you could present students with excerpts from local state and national media articles, or ask them to find their own, to generate ideas about management projects of interest that could be investigated in your class. It also provides opportunities to explore students' prior knowledge about how environmental projects are conceptualised, planned, authorised, and managed.

There are three key knowledge sections in unit three area of study two including the requirement that a particular environmental science case study related to development is studied. Ideally, the selected case study will have associated management and evaluation strategies. Sustainability principles and the processes involved in environmental decision-making and management will be explored by students. Information about some management projects are well-documented and available online for example, the Budj Bim Master Plan. The projects involving field work pre-excursion preparation is invaluable in making the most of the time spent in the field, particularly in understanding changes over time in the stages of the project and the relevance of sustainability and sustainability principles to the project. I'd also recommend that you refer to past VCAA examination papers for VCE Environmental Science. These provide many case studies that you can use in your teaching.

Definitions related to sustainability are important to understand in terms of how they apply to VCE Environmental Science. Students will be expected to be familiar with six sustainability principles that is, conservation of biodiversity and the ecological integrity, efficiency of resource use, inter and intra-generational equity, precautionary principle and user pays principle. Sustainable development is considering terms of what's commonly known as the three pillars, ecological, economic and socio-cultural sustainability. Systems thinking in terms of the interrelatedness of Earth's four systems and the transition from a linear economy where things that may use are disposed to a circular economy where products are reconceptualized in terms of being reused or repurposed are important aspects of sustainability. The value systems of various stakeholders in the management of various environmental projects should also be discussed in terms of project aims and outcomes.

There are three parts in this outcome for unit four area of study one. The intergovernmental panel on climate changes latest assessment report number six, provide useful data related to all three sections and can serve as a starting point for discussions about climate data and about the climate science concepts in this area of study. Extracts from scientific reports or media publications can be used as a source of discussion of climate science concepts or can be used as the basis of assessment tasks. You can also use these reports to consider the nature of evidence in responding to scientific questions. So, for the example on the slide, are asking students how a measure such as emissions per capita could be determined, or whether looking at historical emissions is useful in providing an answer to the question of which nations contribute most to climate change.

Students should be exposed to different graphs of climate data so they can develop skills. in identifying patterns and trends Discussing the scales used on horizontal and vertical axes helps students to make sense of graphs and to be able to draw conclusions from the data as well as to make predictions. Students should have experience in saying and interpreting data that show linear, non-linear and cyclic relationships. There are three key knowledge sections in unit four area of study one.

Well, there are many factors that affect Earth's climate, students will be limited to considering volcanic eruptions, solar variability, and change in atmospheric gas composition due to human activities. Certain methods for measuring past and present changes in the atmosphere are limited to ice core sampling, use of palliate climate records, and atmospheric and ocean temperature monitoring. This leads to the consideration of data related to global average temperatures, local climate extremes, sea level rise, and snow and ice coverage. Both mitigation and adaptation options in dealing with climate change are discussed in this area of study.

There are two parts to this outcome for unit four area of study two, the focus is on the sustainability of different energy options, recognising that different locations will have different energy needs and different access to energy sources. The use of data, again, features in this area of study as students consider different energy options. It is recommended that you access information that is as recent as can be obtained, recognising that there are generally time lags between the generation and collation of data and its publication for general use.

Public quotes about energy sources, availability, and future options may allow students to practise the skill of forming science-justified opinions and developing their scientific literacy. It also enables definitions of terminology to be explored. For example, in this slide, renewable energy. Sustainability principles and sustainable development ideas can also be unpacked. In this slide, the worth of economic sustainability and socio-cultural sustainability, maybe compared with ecological sustainability leading to discussions about the significance of all three of these aspects in considering sustainability as a general concept.

There are two key knowledge sections in unit four outcome two related to renewability of different energy sources and management of the impacts of human energy use. You're encouraged to refer to case studies at different locations, and you can also use past VCAA examination papers for different hypothetical scenarios. There are two parts in this outcome for unit four outcome three related to student designed and performed investigations. Investigation can be based on content in all the unit three and all unit four. Students may initially design investigation recorded in their logbooks, which outlines an appropriate methodology and method. You must approve student designs before the investigation is undertaken, ensuring that all health and safety requirements are met. You should also ensure that the proposed investigation is manageable within the timeframe you have allocated for the task. All work related to the investigation should be recording students’ logbooks and dated each time the entry is made. It is helpful for students if work is progressively marked.

For example, allocating marks for the design stage, the results presentation, the data analysis, and the investigation discussion. This may make up the bulk of students marks with a scientific pass to contributing a small proportion to the assessment. The design of investigation including its assessment may also take place after an initial investigation is performed. Students may undertake an initial investigation and then suggest a follow-up investigation or suggest how the initial investigation could be modified to answer a new question.

There are three key knowledge sections in this outcome for unit four area of study three, designing an investigation, using data from the investigation to respond to a question, and communicating findings of the investigation. At least was a suggested for this area of study so that students have time to understand the theory behind the scientific inquiry in the context of their own investigations. As part of the key knowledge in unit four area of study three, students should understand how controlled experiments involve a dependent and independent, and controlled variable and that not all scientific investigations are controlled experiments. The listed examples on this slide show how different methodologies may be used by students to construct scientific questions of interest when undertaking their own inquiries in this area of study.

The determination of an S or an N for a unit is separate from the determination of the level of achievement. Scores determine the basis on which an S or an N is decided and relates to the satisfactory completion of the outcomes in a unit. School assessed coursework is based on a set of non-native assessment tasks in the study design. School assessed course work for unit three outcome one contributes 12% of the study score, while unit three outcome two contributes 8% to the study score since area of study one is more content heavy than area of study two. Each of the three outcomes in unit four contribute 10% of the study score. These were writings that reflected in the external examination which contributes 50% of the student’s study score. School assessed coursework is moderated against the examination.

All assessment both external and the internal must follow the VCE Assessment Principles. These are, that assessments should be valid and reasonable. They should be equitable, balanced, and efficient. The assessment principles have been explained in a series of short videos available on our website, and I encourage you to take time to access them. How much of an outcome should be assessed? I'm often asked where the teachers need to assess all of an outcome in school assessed coursework, or when determining an S or an N for a unit. If you look at the example of the outcome for unit three area of study one, you'll see that it has three parts highlighted in different colours. In determining an S or an N, all parts of the outcome must be assessed noting the command terms. It would not be enough for example, for a student to describe the importance of Earth's biodiversity, they need to be able to at least explain its importance. Similarly, students should at least be able to analyse the threats to biodiversity and management strategies need to be evaluated, not just described, or identified.

Blooms or other taxonomies are useful for developing questions that are at an appropriate cognitive level for assessment tasks. When developing a SAC task, only part of an outcome needs to be addressed. You may want to consider assessing different parts of an outcome from year to year. There are five assessment tasks that students who are completing units three and four, that will contribute 50% of their study score for environmental science. These tasks are described by assessment task type shown in the right-hand column of the table on this slide and shown on pages 35 and 41 of the study design. Each task type can only be chosen once across units three and four. Unit four outcome three is assessed separately by a poster and local countries. But for the other four areas of study, you can choose which task will be applied to which outcome.

Let's now consider assessment of unit three area of study one. Here are four examples of possible assessment tasks for unit three area of study one in relation to each of the four possible task types listed in the left column of the table. Only one task taught can be chosen per outcome. So, let's imagine that the National Recovery Plan for the orange-bellied parrot is chosen that's the task in the third row of the table. This leaves three other tasks to be distributed amongst the three other outcomes for units three and four. The task types for environmental science have been designed so that they can be applied to all outcomes to enable choice for teachers from year to year. In this example in the slide, the three other possible tasks that were not selected as the assessment tasks for unit three area outcome one could be used in future years where they could be used as part of the current use teaching programme.

This is a sample plan showing one teacher's assessment scheme across units three and four, one different task type has been selected for each area of study, so each assessment task is used only once across units three and four. Each of the five assessment tasks across units three and four should be aligned to the relevant parts of the key knowledge in the selected outcome. The tasks also align with employability skills and key science skills as shown in the next five slides. This is the first task related to evidence-based decision making. The task must include primary data generated by the student. Different employability skills in key science skills apply to each assessment task. This second task focus on innovation and may involve analysis of a provided innovation or may require students to generate a solution themselves, keep in mind that assessment tasks should between 50 and 70 minutes. The third task focuses on sustainability and stakeholder perspectives. Some tasks could involve a comparison of different responses from different stakeholders, particularly in identifying underlying stakeholder values, including whether the stakeholders have taken an anthropocentric, biocentric, ecocentric or technocentric view. And which of the six sustainability principles may apply to the scenario in the assessment task.

Some tasks may require that you provide students with reading materials such as the actual case study or a media article in which the assessment task is based to be read outside class time. Aspects may also be discussed in class prior to students undertaking the assessment task. Care needs to be taken however, if parts of an assessment task is completed outside class. The VCAA Authentication Form may be used for such work. A number of different employability and key science skills apply to the student designed investigation task. In approving different student investigations in the class, you need to ensure that the tasks are comparable, especially if different students use different methodologies.

Outcome three requires students to produce a scientific poster to communicate the results of their investigation related to unit three and/or unit four. The poster will contribute to their assessment for the outcome in addition to the logbook entries. Students should be assessed on their ability to design the experiment, to present, organise, analyse, and evaluate their data and communicate their findings. It's up to you as to what working you place on each of these aspects. The poster itself, for example, may only contribute a small proportion to the overall assessment whilst greater emphasis may be placed on a logbook entries. Use the QR code to think about how the reduced word count for the poster from a thousand words to 600 words supports more effective science communication. The next eight slides show examples of student posters using the new format that illustrate particular aspects of the management of this outcome.

Different scientific methodologies may be used in student investigations. Here's an example of the use of field work as a basis of the investigation where students applied Simpsons Index to evaluate data. In this class, students generated their own data and class results were collated and provided to all students so that they had sufficient data to draw a conclusion. Students might always find that there is a relationship between the variables if investigated as in this example. This is not an issue as long as students attempt to explain why a relationship may not exist. We've got a correlational study here. Students made their own observations, and again, class data was collated in order to establish any relationship between variables. This particular study also required the use of field guides for bird identification.

Students and science projects can be used as a basis for student investigations as long as students contribute to the generation of primary data. Longitudinal data that is past data, as well as current data may also be used as the basis of student investigations. Again, as long as students contribute to the data generation. The unit four outcome three student investigation can relate to any part or parts of units three and/or four. In this example, environmental management is a basis of the investigation which relates to unit three area of study two with the inclusion of the use of Simpsons Index to assess biodiversity, which relates to content in unit three area of study one. It is also possible to combine different content across units three and four.

Modelling is a useful methodology, particularly in simulating large systems. In this investigation, beacons of salty water of different concentrations model the ocean and icebergs are modelled by ice cubes. Controlled experiments would have then been performed to generate relevant data. In this investigation, controlled experiment was performed with the students subsequently explaining its relevance in terms of climate science adaptation. Our final student poster example is another modelling investigation. You need to be careful that students proposed investigations are manageable within the framework of approximately 10 hours to cover the teaching, experimental work, and assessment of this area of study.

This session was an overview of content and assessment for units three and four. We're planning a live Q and A session in February 2022 so that I can respond to any queries that you may have. But please feel free to contact me at any time if there's anything you'd like to know or to discuss. I look forward to continuing to work with you.

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