

Water in the Australian Curriculum: Science

This PDF is
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resources.

1. BACKGROUND

For the water industry, the national implementation of the Australian Curriculum: Science Foundation to Year 10 (F-10) represented a valuable opportunity to promote student and teacher understanding about key water topics and issues. In response, the Australian Water Association sponsored an education project – the AWA Australian Curriculum Project (ACP) – from 2013 to 2015. The aims of the project were to:

- explore how key water topics fitted in the Australian Curriculum
- identify opportunities to promote existing quality resources that were already aligned to the Australian Curriculum
- develop new resources to fill identified gaps for a national audience.

The ACP was funded by interested Australian Water Association member agencies and commenced 5 March 2013. The project began with an analysis of water topics in the Australian Curriculum, an audit of existing curriculum resources with a gap analysis and recommendations for further actions. It focused on the Science, Geography and History subject areas. This report on the role of water in the Australian Curriculum: Science and two similar reports for Geography and History are available on the [Australian Water Association website](#).

The project focused predominantly on Science, Geography and History F-10 because these subject areas had been endorsed by all State and Territory Education Ministers for implementation. In 2013, to gauge the relative importance of 'water' in different subject areas, the Australian Curriculum website was searched for water-related references. The search results listed 133 references. Of these, 66 were found in Science and 65 references in the Humanities of which 52 were found in Geography and 13 were found in History. There were two references to water in the Mathematics curriculum (Figure 1). Of course, water contexts can be used in other subject areas such as English but they are not explicitly referenced in the curriculum.

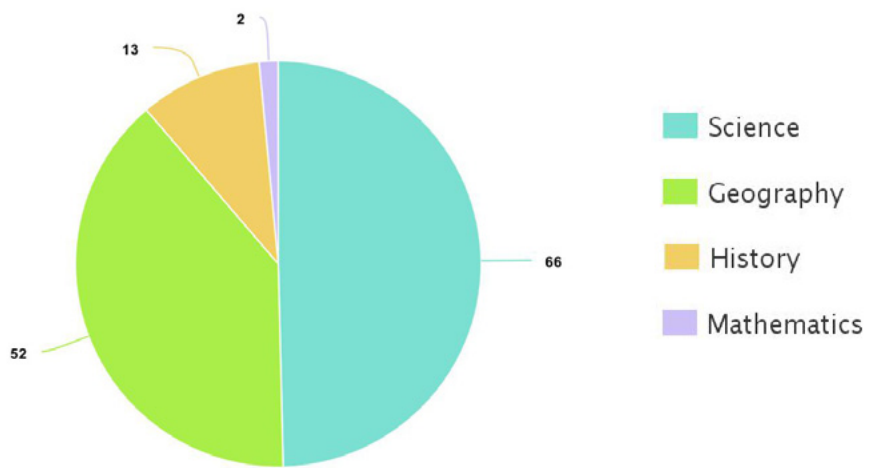


Figure 1 'Water' search results for the Australian Curriculum (accessed September 2013)

As the Australian Curriculum: Science was released first in December 2010, more aligned resources were available for this learning area. The Australian Curriculum: Geography was released in May 2013 enabling relevant Geography curriculum resources to be included in the audit. The later release of the Australian Curriculum: Technologies provided another targeted opportunity to incorporate water-related engineering activities into the curriculum and promote an awareness of water industry careers. However, it was not included in the scope of the project. Some analysis of the Senior Secondary Australian Curriculum subjects has been addressed in these reports. However, these curricula have not been endorsed for national implementation as yet.

Note that changes were made to the Australian Curriculum: F - 10 in 2015 in response to the 2014 Review of the Australian Curriculum. These changes are reflected in the [v8.1 F-10 Curriculum](#) and references to specific content descriptions have been updated in the Science, Geography and History water education curriculum reports.

In the 2013-2014 curriculum audit, the Science, Geography and History subject areas were addressed in a similar way. Starting with a list of online free resources suggested by project subscribers and stakeholders, current water-related resources were audited. 'Hotspots' for water topics were identified in content descriptions in particular year levels of the Australian Curriculum (Appendices A-D). For instance, there is a Science 'hotspot' in Year 7 where teachers of science would be actively seeking water-related resources about the water cycle.

Water industry educators from the Australian Water Association Water Education Network provided a list of key water topics they considered important to include in the school curriculum. Figure 2 shows the topic mapping for Science. These topics were mapped against subject area topics and year levels in a water topic curriculum matrix to establish in which year levels particular topics are most likely to be taught.

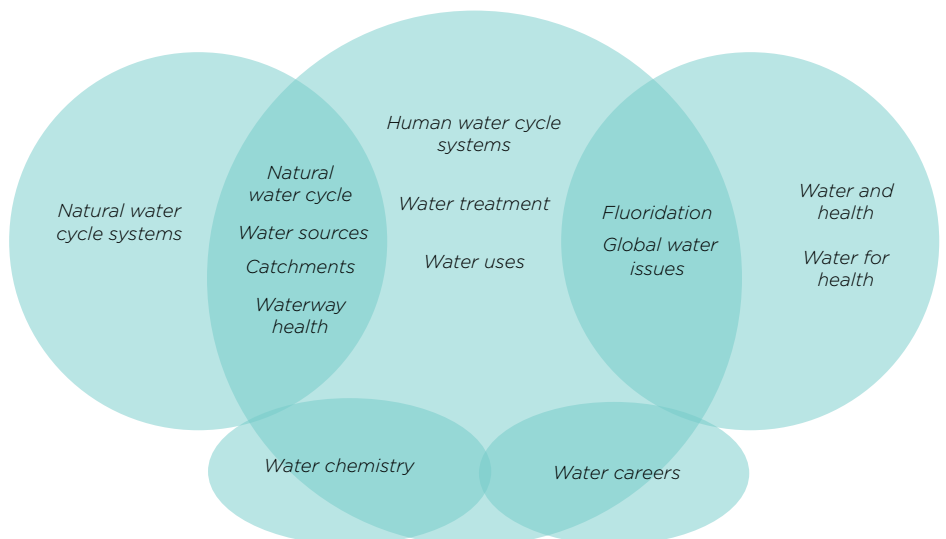


Figure 1 Year 7 Australian Curriculum content description relating to water

Existing resources that referenced Australian Curriculum content descriptions were reviewed against quality criteria and ten high quality recommended Science and Geography resources were selected for promotion through the AWA website.

AUSTRALIAN CURRICULUM: SCIENCE

To explore the opportunities presented by the Australian Curriculum: Science F-10, this report addresses the following questions:

1. What is the rationale that underpins the curriculum? What clues does the Science curriculum provide about the kinds of activities and teaching approaches it favours?
2. Which topics are explicitly addressed? In which year levels do these topics occur?
3. Which resources are already aligned to the Australian Curriculum: Science?
4. Where are the gaps in the current online water-related curriculum resources?

2. RATIONALE AND TEACHING APPROACH

In the Australian Curriculum, Science is 'a dynamic, collaborative and creative human endeavour arising from our desire to make sense of our world through exploring the unknown, investigating universal mysteries, making predictions and solving problems'. The Australian Curriculum: Science focuses on developing student understanding about science and its contribution to our lives. It seeks to 'develop the scientific knowledge, understandings and skills to make informed decisions about local, national and global issues and to participate, if they so wish, in science-related careers' (see footnote 1). The Science curriculum also highlights the importance of nurturing students' sense of discovery and curiosity as they explore their world.

Consequently, this curriculum takes an inquiry-based approach to teaching and learning and emphasises the value of student-led open inquiry. It identifies a typical teaching and learning framework as 'context, exploration, explanation and application' using contexts which link meaningfully to students' experiences. Clearly water topics meet this criterion.

There are six overarching ideas that underpin the Australian Curriculum: Science—patterns, order and organisation; form and function; stability and change; systems; scale and measurement; and matter and energy. The curriculum is divided into three strands: Science Understanding, Science Inquiry Skills and Science as a Human Endeavour. Within these strands, what students should be taught is described in content descriptions.

Teachers are expected to integrate the three strands in a unit of work. Usually, teachers plan a unit of work using the year level Science Understanding content descriptions, designing learning activities which address the relevant Science Inquiry Skills and Science as a Human Endeavour content descriptions for that year level. The Science Understanding strand is divided into four sub-strands: Biological sciences, Chemical sciences, Earth and space sciences and Physical sciences.

1 Australian Curriculum F-10 v8.2 © Australian Curriculum, Assessment and Reporting Authority (ACARA) 2010 to present, unless otherwise indicated. This material was downloaded from the Australian Curriculum website (<http://www.australiancurriculum.edu.au/>) accessed 1 August 2016 and was not modified. The material is licensed under CC BY 4.0. Version updates are tracked on the Curriculum version history page of the Australian Curriculum website. ACARA does not endorse any product that uses the Australian Curriculum or make any representations as to the quality of such products. Any product that uses material published on this website should not be taken to be affiliated with ACARA or have the sponsorship or approval of ACARA. It is up to each person to make their own assessment of the product, taking into account matters including, but not limited to, the version number and the degree to which the materials align with the content descriptions (where relevant). Where there is a claim of alignment, it is important to check that the materials align with the content descriptions (endorsed by all education Ministers), not the elaborations (examples provided by ACARA).

3. WATER-RELATED TOPICS AND OPPORTUNITIES IN YEAR LEVELS

As mentioned, key water topics identified by water educators were mapped against the Australian Curriculum: Science F-10 and the relevant Senior Secondary Sciences curricula and are shown in Appendices A to D. The following observations describe some of the key 'hotspots' where water topics appear and are listed in order of importance.

- Year 7 provides the strongest opportunity to teach water-related topics across the Biological sciences, Chemical sciences, and Earth and space sciences sub-strands. Relevant topics include water cycle systems, catchment processes, waterway health, ecosystems, the chemistry of water mixtures and solutions and water treatment processes (separation techniques).
- Chemical sciences content descriptions also provide opportunities for a cross-phase sequence of activities from Foundation to Year 7 that develop student understanding about the properties and interactions of water culminating with separation techniques (water treatment processes) in Year 7.
- Similarly, teaching about local catchments and waterway health can effectively address the Biological sciences content descriptions from Foundation to Year 7 (except for Year 2) and Earth and space sciences content descriptions in Years 2, 4 and 7.
- These cross-phase water topic sequences in Chemical sciences and Earth and space sciences are particularly attractive to teachers catering for multi-age classes.
- The Foundation year provides ample experiential opportunities to introduce students to water topics.
- Different aspects of managing water wisely are covered well in the Science as a Human Endeavour strand from Years 1 to 10.
- Curriculum resources showcasing different elements of water-related careers can be used in Years 5 to 10.
- The two cross-curriculum priorities of Sustainability and Aboriginal and Torres Strait Islander Histories and Cultures can be readily addressed across many of the year levels using a range of water contexts.
- In the middle years, there is scope in Year 9 Biological sciences to investigate the local waterway. The molecular nature of water can be explored in Year 8 Chemical sciences and Year 10 Earth and space sciences includes the study of the hydrosphere and its interaction with the other global systems.

AUSTRALIAN CURRICULUM: SENIOR SECONDARY SCIENCE

The Senior Secondary Science Australian Curriculum subjects are Chemistry, Earth and Environmental Science, Biology and Physics. These curricula are each organised into four units to be covered in Years 11 and 12. The curriculum itself is described in the content descriptions and examples of how these content descriptions might be taught are provided by the Examples in Context statements. Water-related content descriptions are found in Chemistry, Earth and environmental science and Biology and are listed in Appendices B to D. Note that the senior curricula have not yet been widely implemented nationally.

Chemistry

The senior Chemistry curriculum promotes the use of real world 'contexts that exemplify the role of chemistry and chemists in society' (see footnote 2). It includes opportunities for ensuring a supply of clean drinking water using chemical knowledge and a range of technologies. Water is a very useful context to explore the properties and structure of materials and separating techniques mentioned in Unit 1. Targeted lesson resources on advanced treatment technologies such as membrane or activated carbon could be useful here.

2 Australian Curriculum, Assessment and Reporting Authority <<http://www.australiancurriculum.edu.au/seniorsecondary/science/chemistry/rationaleaims>> As above. Accessed 28 June 2016

Water topics are strongly indicated in Unit 2 which includes a section on aqueous solutions and acidity. One of the Examples in context for this topic relates to drinking water quality and desalination.

Unit 3 includes a section on oxidation and reduction reactions which can be demonstrated with a range of water treatment processes such as disinfection. One of the Examples in context addresses the use of electrochemistry in water treatment applications.

Earth and Environmental Science

Water topics—not surprisingly—form a conceptual thread through three of the four Earth and Environmental Science units starting with the origin and chemistry of water, and the hydrological cycle in Unit 1. However, Unit 3: ‘Living on Earth - extracting, using and managing Earth resources’ provides the strongest opportunity to deliver lessons on renewable resources, the human water cycle and the impact of human activities on ecosystems such as catchments. One of the Examples in context is coal seam gas extraction in Australia. Unit 4 deals with the hazards of droughts, floods and cyclones.

Biology

The senior [Biology](#) course can incorporate waterway health elements in Unit 1: ‘Biodiversity and the interconnectedness of life’—particularly when investigating human impacts on catchment ecosystem dynamics. Biological nutrient removal at wastewater treatment plants could be used as a context to teach about the nitrogen cycle.

Osmosis appears as a topic in Unit 2 and could be compared with reverse osmosis water purification or reverse osmosis in a desalination plant. This unit explores cells and multicellular organisms so microbial wastewater treatment processes could also be discussed here.

4. EXISTING RESOURCES — SCIENCE F-10

Of the 182 online water curriculum resources identified in the ACP curriculum audit of existing resources in 2013, over 90 were Science resources. Of these, 26 resources were aligned to either the final version or earlier drafts of the Australian Curriculum: Science. This exercise indicated the wealth and quality of the existing resources and the need to ensure that these resources are linked to the Australian Curriculum and accessible to teachers.

The 26 resources linked to the Australian Curriculum were evaluated by the ACP Steering Committee using the criteria of pedagogical value, suitability and design/usability. Of the 26 resources, they identified seven resources that exemplified best educational practice in science education.

These resources were:

[How do we use water?](#) Early stage 1 resource – Sydney Water

[Make your watermark!](#) Foundation lesson plans – Gold Coast City Council

[Wonder of water:](#) Year 2 Science unit – Queensland Government

[Water works:](#) Year 2 Science unit – Australian Academy of Science Primary Connections Program. Teachers registered with Scootle can access the unit from this link. Alternatively, use the search terms ‘water works primary connections’ to find the link to the PDF of the document from the Australian Academy of Science.

[Enough water fit for drinking:](#) Year 7 Science unit – Australian Academy of Science Science by Doing Program. If you are not registered with the Science by Doing program, use the search terms ‘enough water fit for drinking’ to view the student version of the resource.

[The Lake Eyre Basin:](#) Year 7 Science and Geography unit – Australian Government Department of Environment

[The Great Artesian Basin:](#) Year 7 Science and Geography unit – Australian Government Department of Environment

5. GAPS AND RECOMMENDATIONS

SCIENCE FOUNDATION TO YEAR 10

While there is always scope to develop more engaging and effective curriculum resources for Science Foundation to Year 10, the audit indicated that a number of the usual water-related topics are already covered in the available units of work or lesson sequences.

However, gaps in Australian Curriculum aligned resources were identified according to the. Some of the content descriptions have changed and the updated Australian Curriculum F-10 v8.1 content descriptions are listed below (see footnote 3).

Catchments and waterway health

There is an opportunity to promote lesson activities in the area of catchments and waterway health in lower Primary. The relevant v8.1 content descriptions (see footnote below) are:

- Biological sciences

Year 1: Living things live in different places where their needs are met (ACSSU211)

Year 3: Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044)

Year 4: Living things depend on each other and the environment to survive (ACSSU073)

- Earth and space sciences

Year 4: Earth's surface changes over time as a result of natural processes and human activity (ACSSU075)

Chemistry of water

Similar gaps exist for the chemistry of water topic in the lower and middle Primary years. The content descriptions in the Chemical sciences sub-strand for which resources have not yet been identified include:

Year 3: A change of state between solid and liquid can be caused by adding or removing heat (ACSSU046)

Year 4: Natural and processed materials have a range of physical properties; these properties can influence their use (ACSSU074)

Year 5: Solids, liquids and gases have different observable properties and behave in different ways (ACSSU077)

Fluoridation

While the topic of fluoridation could be included in Year 7 Chemical sciences, no relevant resources have yet been identified. A teacher guide could be developed to address this gap in the short term but the release of the Health and Physical Education curriculum provides another opportunity to promote understanding about this topic—particularly in Years 9 and 10.

- Water Sensitive Urban Design

Resources about water sensitive urban design (WSUD) principles are poorly represented in current resources. Melbourne Water is one of the few agencies that has published WSUD education resources.

- Newer water topics

There is a shortage of lesson plans for newer water topics (e.g. water recycling, groundwater and desalination). Additional resources are required to adequately develop student and teacher understanding of these topics.

3 Australian Curriculum, Assessment and Reporting Authority (ACARA) <<http://www.australiancurriculum.edu.au>> As above. Accessed 28 June 2016

- Water careers

The audit indicated a lack of awareness among curriculum writers about the need to promote water-related careers. Teacher guides could be developed to augment existing curriculum resources to include lesson activities featuring water career pathways.

- Gaps in Senior Secondary Science

The curriculum audit identified very few water-related resources for senior secondary students and no resources that are currently aligned to the Australian Curriculum. This is not surprising as much secondary science is taught from a textbook rather than from online curriculum resources. Notable exceptions to this observation are the senior science [Make your water mark!](#) resources published by the Gold Coast City Council and the [Teaching resources](#) developed by the Water Corporation in Western Australia.

Rather than developing full units of work for senior secondary classes, it might be more beneficial to focus on individual lesson plans or short teacher guides using interesting real world contexts and data to promote cutting-edge water science and/or management and highlight the personnel involved in this work.

RECOMMENDATIONS

Teacher guides

One option suggested by Education Services Australia (ESA) for new resources was to develop short targeted teacher guides comprising lesson plans using existing online curriculum activities such as the Victorian [Water. Learn it. Live it.](#) resources. These lesson plans could show how a sequence of activities can address engaging real world water contexts, promoting not just an understanding of water-related topics but also an understanding of the water industry and its career pathways.

These teacher guides could also provide lesson ideas for teachers which show how parts of existing published data and reports (from agencies such as the Murray Darling Basin Authority) can be used in the classroom to address the requirements of the Australian Curriculum. ESA provided examples of teacher guide templates which were adapted for the ACP teacher guides. These teacher guides have been published on the Australian Water Association website.

6. IMPLEMENTATION

While this report identified a range of short and long term recommendations for consideration, within the term of the Australian Curriculum Project, the following Science teacher guides were completed for online publication:

- *Investigating our local waterway - for Years 4 and 5*
- *Investigating our local waterway - for Years 6 and 7*
- *Investigating our local waterway - for Year 9*
- *Using membrane technologies to separate water: Year 7*
- *Using science and technology to solve Australia's water problems: Year 7*

These teacher guides can be found [here](#) on the Australian Water Association website. Clearly, the development and promotion of best practice curriculum resources is an ongoing task for the water industry. However, it remains an important element in ensuring that ever more critical decisions about managing our water are made by an informed community. Teachers, students and their families make up a significant proportion of our community and are our ambassadors for future decision making.

The *Appendix: Water topics in Australian Curriculum: Science Foundation to Year 10* can be downloaded [here](#).



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