# A JOINT RESPONSE TO THE DRAFT K-10 AUSTRALIAN CURRICULUM: SCIENCE

**STAV RESPONSE TO ACARA AUSTRALIAN CURRICULUM, SCIENCE**

**K – 10 DRAFT DOCUMENT**

The Science Teachers' Association of Victoria (STAV) has been representing the collective voice of science educators in Victoria since 1943 and welcomes the opportunity to respond to the ACARA Australian Curriculum, Science K – 10 Draft document.

STAV currently has over 1,000 members and together with the Chemistry Education Association (CEA), the Royal Australian Chemical Institute (RACI) Victorian Branch Chemical Education Group and the Australian Institute of Physics (Victorian Branch) Education Committee planned and facilitated six Consultation Forums across the state, providing science educators with an opportunity to give feedback on the draft document.

There was overwhelming support for a national approach to science, underpinned by inquiry-based pedagogy and a unanimous feeling that the Australian Curriculum, Science document should be a framework not a syllabus.

The organisation of the curriculum into the three strands, Science Understanding, Science Inquiry Skills and Science as a Human Endeavour, was favourably received. There was however a concern that the interrelationship between the strands was not clearly articulated and that the elaborations did not link well across the strands. There was strong support for the development of the two strands, Science Inquiry Skills and Science as a Human Endeavour over a two-year phase, but there was disappointment that the third strand, Science Understanding was developed on a year-by-year phase. This approach would not allow for flexibility in the delivery of the curriculum at a local level, which we currently experience in Victoria under the VELS framework.

The inclusion of the general capabilities (literacy, numeracy, information and communication technologies (ICT), thinking skills, creativity, teamwork, ethical behaviour and self-management, social competence and intercultural understanding) in the content descriptions and achievement standards is a major strength, equipping the students with the skills necessary for their participation as competent global citizens in the 21st Century. However there were concerns that the emerging sciences such as photonics, nanotechnology, designer materials & DNA technology were not included and that the achievement standards were very content based.

There was a strong belief that adequate provision for resources (physical and time) including Professional Development for existing teachers (Primary & 7 – 10) and Pre-Service teachers must be considered to ensure that the K – 10 Science Curriculum is implemented with confidence and competence.

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STAV President

Following is a summary of the views expressed by the teachers who participated in the Consultation Forums.

## POSITIVE FEATURES OF THE CURRICULUM

We believe the development of Science Inquiry Skills is crucial and applaud the inclusion of this strand and the enquiry-based learning approach, as well as the emphasis on critical thinking skills and the drawing of evidence-based conclusions.

We also support:

- the inclusion of the theme of sustainability;
- the organisation of the curriculum around the three strands;
- the statements of general capabilities that should be embedded in the Science curriculum; and
- the statements of links to other learning areas, including the rationale behind them.

## SUMMARY OF CONCERNS

**Teachers at the joint forums were asked to respond to seven key statements. They also stated a number of other concerns.**

**Reponses to the seven statements will be considered first.**

**STATEMENT 1** **The Australian Curriculum: Science provides our students with opportunities to meet the challenges of the 21st century**

Responses ranged from disagree to agree. Those who agreed qualified this by saying it would depend on the time permitted, funding and teacher professional learning available.

1.1 Many teachers commented that although the inquiry-based learning approach has the potential to provide students with important skills needed for the 21st century, the curriculum is so packed there will not be enough time for students to achieve deeper understandings, or to develop the ability to draw evidence-based conclusions and to think critically. All of these are vital skills for the 21st century.

1.2 Many teachers also expressed concern that the new emerging sciences were not listed. These include DNA technology, photonics, nanotechnology, neuroscience and designer materials. Students need to be exposed to these if they are to develop scientific literacy skills and understandings and fascination with Science that will prepare them for the future.

**STATEMENT 2** **The Australian Curriculum: Science emphasises and enables an inquiry-based model of teaching**

Responses ranged from strongly disagree to agree. One discussion group strongly agreed that the curriculum emphasises the inquiry-based model but disagreed that it enables this to occur.

2.1 There was general agreement that the inclusion of Science Inquiry Skills and thinking skills, including the emphasis on drawing evidence-based conclusions, is a very positive aspect of the curriculum.

2.2 Although, the advice has been given that the stated elaborations are intended as examples only, the sheer number of them is likely to cause some teachers to over-emphasise this strand at the expense of the other two strands. Many teachers are stated that the Science Understandings strand is so over-packed they "won't have time to do the other two strands". Yet the development of strong Science Inquiry skills and critical thinking skills takes a lot of time. There is great concern that students will only learn 'about' and not learn to do. There needs to be the opportunity for deep learning and mastery, rather than jamming in content.

**STATEMENT 3** **The Australian Curriculum: Science clearly demonstrates the interrelationship between the three strands: science inquiry skills, science as a human endeavor, science understanding**

The majority of teachers disagreed or strongly disagreed with this statement. Some did agree or strongly agree.

3.1 One group stated that an authentic approach to delivering the curriculum would be a seamless integration of the three strands.

3.2 While some teachers felt there is a good flow between the three strands and they would not have a problem in devising a program in which the three were interwoven, others felt that that the elaborations do not link well across the strands. The links need to be more precise and explicit. Some felt, for example, that the references to the contributions of different cultures in the Science as a Human Endeavour strand do not link well to the Science Understandings strand. Others felt that much of the stated content for these two strands does not lend itself to appropriate practical investigations for the Science Inquiry Skills strand. This is particularly the case for the large amount of content on geology and weather.

3.3 Teachers stated that unless there is stronger connection between the Science as a Human Endeavour strand and the other two strands, students will not be in a position to explore the topic with any degree of understanding and critical thinking or to draw evidence-based conclusions.

3.4 Many teachers stated they will rely heavily on textbooks to show them how to achieve an integrated approach. But there are concerns that some textbooks will not do this well and that many teachers will be too reliant on textbooks.

3.5 There also was concern about the relative amount of time that would be given to the three strands. The Science Understandings strand was so packed with content for Years 3, 6, and 7-10 they felt they would not have sufficient time to achieve a good balance between the three strands.

3.6 The draft curriculum states that equal importance should be attached to the three strands. Teachers questioned whether 'equal importance' means that equal time should be allocated to these three strands. To be fully and properly implemented, the listed Science inquiry skills would take more than one third of the time that might be allocated to Science at these levels. In developing these skills, many aspects of the other two strands can be addressed through the practical investigations that might be developed.

3.7 It is not made clear that the stated elaborations for the three strands are examples of what can be done. On reading the elaborations, and comparing the lengths of the statements in the three columns, the implication is that the three strands are not of equal importance at all. Their order of importance on this basis is Science Understandings > Science Inquiry Skills > Science as a Human Endeavour.

**STATEMENT 4** **In the Australian Curriculum: Science there is a clear connection between the descriptors, elaborations and achievement standards**

Almost all groups disagreed or strongly disagreed with this statement.

4.1 It was felt that the statements of achievement standards were too vague in terms of what the student is expected to be able to do. Are they benchmarks for all students to achieve?

4.2 There was strong agreement that the achievement standards should not be part of a national testing program such as NAPLAN.

4.3 There also was strong agreement that the stated achievement standards are very content-based and there need to be guidelines provided on the assessment of Science inquiry skills and of the Science as a Human Endeavour strand.

**STATEMENT 5** **The Australian Curriculum: Science will enable the development of science programs that will cater for the range of student abilities and interests**

Almost all groups disagreed or strongly disagreed with this statement.

5.1 It was noted that two of the strands, Science Inquiry Skills and Science as a Human Endeavour, are developed over two-year phases while the third strand, Science Understanding, is developed on a rigid year-by-year basis.

5.2 Schools must cater for students who have a great range of abilities, emotional and social maturity, and backgrounds. Many Victorian schools provide outstanding programs designed for students of Years 9 and 10 to meet their special learning and emotional and social needs, which needs are well documented in many studies. These can include extension programs, Science Talent Quests and CREST programs, programs where students spend an entire term or semester or year in a different location, such as in a rural area, and special interest programs, such as marine science programs at schools that are located near the sea. The development of Science Understandings on a year-by-year basis will impinge significantly on these provisions. Teachers stated that their schools need the flexibility to be able to continue providing these very effective and highly valued programs.

5.3 Teachers also pointed out that the best learning model for students is the spiral learning model, with an emphasis on "big ideas". Neither of these is evident in the curriculum, which is more a patchwork of ideas that do not develop in logical pathways. There is no clear progression from year to year and some parts are repeated unnecessarily. This will mean many students will struggle to cope with the curriculum, and will become disengaged. There is no evidence that a differentiated curriculum will be possible to cater for students of different abilities.

5.4 It was noted that in Victoria, many schools run their Year 10 Science program in trimesters, teaching a term of Biology, a term of Chemistry and a term of Physics, so students can make informed choices when selecting their senior science subjects. This has proved very worthwhile but is not possible under the current proposal.

5.5 It also was felt that students who are likely to further their studies in Science in Years 11 and 12 are not well catered for as the Years 9-10 curriculum is not rigorous enough to provide the preparation they need.

**STATEMENT 6** **In constructing the Australian Curriculum: Science the proposed minimum time (per week) guide for the writers was:**

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|---|---|
| **K TO 2** | **1 HOUR** |
| **YEARS 3-6** | **2 HOURS** |
| **YEAR 7** | **3 HOURS** |
| **YEARS 8-10** | **4 HOURS** |

**This allows for deep and meaningful learning.**

Almost all groups disagreed or strongly disagreed with this statement, on the grounds that while this amount of time is ideal and would allow time for deep and meaningful learning to take place if the curriculum were less packed, it is not possible at their school to allocate this amount of time, especially from Years 8-10.

6.1 It also was felt that this time allocation would out too much pressure on school resources. There would not be enough resources, laboratory staff, Science teachers or dedicated Science rooms to make this possible.

6.2 It was suggested that the final agreed time to be spent on Science should be mandated so ensure it happens.

**STATEMENT 7** **In the Australian Curriculum: Science document, the type of professional development that meets the needs of all stakeholders: classroom teacher, science faculty team, school system, wider school community (students, parents, partnerships) has been considered.**

Almost all groups strongly disagreed with this statement, on the grounds that there is no overt statement about the provision of teacher professional learning in the document.

**It was agreed that:**

7.1 The curriculum will not be able to be implemented with any degree of success unless schools, including primary schools, are properly resourced with sufficient equipment, and well-trained laboratory staff and Science teachers.

7.2 All pre-service teachers and primary school teachers, and many Years 7-10 Science teachers, will require considerable professional learning, including hands-on experience of practical investigations, and follow-up support to enable them to implement this curriculum with confidence and competence. Most Victorian primary teachers have no Science background and even when they studied science in secondary school they were not taught by the inquiry-based approach. Many secondary Science teachers of Years 7-10 also do not have a strong Science background or the necessary Science Inquiry Skills or experience in inquiry0based learning to be able to effectively implement the program.

7.3 There are some curriculum areas that most teachers have little experience in, such as geology and weather, and professional learning will be required in these content areas.

7.4 Time will need to be made available during teaching days for teachers to undertake the professional learning, to attend professional updates in their curriculum areas, to devise their new programs and to develop and participate in strong support networks to help them implement the curriculum. It is unrealistic and counterproductive to expect them to undertake this all in their own time after a full day of teaching.

## Other concerns

### Cross-curriculum dimensions

Although teachers in general support the integration of the cross-curriculum dimensions into the Science curriculum, and agree that students should be exposed to our range of Aboriginal and Torres Strait Islander cultures, and the specialised knowledge and wisdom they have contributed, teachers felt that this dominates the curriculum at the expense of the cultures of many students. For example, there is a relatively small allusion to contributions from Asia, and no mention of the very significant contribution of Middle-Eastern cultures to Science, despite the fact that this is a very multicultural society and many schools have a very large population of students from a range of Asian and Middle-Eastern backgrounds. In addition, teachers felt that as many of schools also have increasing numbers of students from Africa and some from South America, their cultures should also be considered.

There was also considerable concern about obtaining suitable resources for the inclusion of so much content on the contributions from Aboriginal and Torres Strait Islander cultures.

**The development of Science Inquiry Skills**

The list of Science Inquiry Skills for Years 7-8, as stated in the elaborations, is very comprehensive. However, some teachers felt that students of this level should be able to understand the concept of a hypothesis and be able to construct and test simple hypotheses. These are absent from the list of skills expected for these year levels.

**There also was a concern** that it is not overtly stated in the Science Inquiry Skills strand that students should **perform** and **evaluate** the practical investigations they design.

### The Science as a Human Endeavour Strand

Many teachers felt that while some parts of the proposed curriculum are not rigorous enough, many of the elaborations in particular have been dropped in without due regard to the background knowledge of the students or their age, which would mean there could only be a superficial treatment of the concepts and skills at that point.

### Science Understandings

Teachers felt that some of the topics are not appropriate to the age and level of knowledge of the students. As a result, they could only be covered superficially, which would detract from them and cause students in later years to become uninterested as they have considered this before.

Teachers were concerned that topics that are known to engage students, such as forensic science and nanotechnology, and important key topics, such as botany, are not mentioned. Also, as Psychology is studied in Victoria, some teachers were disappointed that this is not included.

They also were concerned that there is an overemphasis on Earth Science/Geology, to the detriment of Chemistry and Physics, especially in Years 9 and 10. In addition, they felt that the curriculum will detract from the possibilities that can be offered in the Geography curriculum.

Some teachers assumed that the different topics listed in the Science Understanding strand should be taught in the order in which they are listed in the document. There was a concern that each year level lists the Chemistry content last;

the implication of this is that Chemistry is of least importance. If teachers run out of time, the Chemistry content may be rushed or omitted.

While teachers recognised that this is a curriculum and not a syllabus, and that the elaborations are intended as examples of what the teachers might do, even though this is not overtly stated in the document, many identified a lack of rigour, especially within the proposed Chemistry and Physics content. Some teachers described the curriculum as "a mile wide and an inch deep".

For example, it was felt that:

• Photonics, more in-depth studies of electricity and electronics should be included in the Physics curriculum.

• Stellar Evolution, and what will happen to our Sun, is a topic in which Year 10 students are intrinsically interested. Australia has a proud history in observational astronomy.

• Image formation by light: Students should understand how light forms images in plane and concave mirrors, and convex lenses using a simple ray diagram. This understanding should be able to be applied to the operation of the human eye and how it adjusts for objects at varying distances, as well as to telescopes and microscopes.

• Half-life: The concept of 'half life' should be explicitly mentioned in Year 9: 'Atoms' if students are to make sense of carbon dating.

• Power: The concept of Power, the rate of energy consumption/production, is essential for an informed discussion on electricity or renewable energy. It can be added as an elaboration in Year 9: 'Electrical energy'.

• Heat Capacity: Students should be aware that substances require different amounts of energy to increase their temperature. This is also useful in the study of renewable energy.

• Year 10 students should be able to predict the products of many chemical reactions and write balanced chemical equations, explain the properties of a number of classes of substance in terms of their structure and bonding, and use systematic nomenclature for simple organic compounds. They also should be able to explore areas of Chemistry such as nanotechnology, and new materials such as conducting polymers.

• By Year 9, students should be able to determine the chemical formulas of many substances, and grasp the principles of the enhanced greenhouse effect, global warming and climate change, in order to make reasoned judgments about the relative merits of different energy resources. (There seems to be some confusion between energy and forces in some parts of the curriculum. This needs to be corrected.)

• In addition, Year 9 students should be able to perform analyses such as identifying unknown compounds by simple tests based on discoveries they have made through systematic testing of properties.

• Years 7 and 8 students can and should be introduced to the Periodic Table and use it at their level. For example, it can be tied in with the exploration of atomic structure and of the differences between pure substances and mixtures, elements and compounds.

• Year 7 students should be able to grasp the basic concept of particle theory, in order to understand the reasons why different separation techniques work with different substances, and why chemical change is generally not reversible while changes of state are normally, but not always, reversible. (The claim in one elaboration that 'changes of state are reversible' needs qualification; it is incorrect since some substances decompose on heating.)

• The term' chemical reaction' should be used from Years 7-10.

Teachers also believed that there should be a more logical development of understandings and skills, including quantitative skills, in these enabling sciences and in the Biology curriculum.

At the same time most teachers were very concerned about the disproportional amount of earth sciences in the curriculum. They felt that some of this could be integrated into Geography instead.

## RECOMMENDATIONS

As a result of teacher responses, we would like to make the following recommendations with respect to the K-10 Australian Curriculum: Science.

1. Use the term '**chemical,** biological, physical and technological' in the Rationale and Aims.
2. Extend the reference to Asia to other cultures, both ancient and modern, and elaborate these in the same manner as for Aboriginal and Torres Strait Islander peoples. Weave these into the elaborations for the Science as a Human Endeavour and Science Understandings strands. All students should have an opportunity to take pride in the contribution of their culture as well as learn to value that of others.
3. Change the Science Understandings strand to a two-year phase as is the case of the other two strands, to enable school programs to be more flexible and to meet the needs of all students. Also increase flexibility by organizing the curriculum into core topics and elective topics.
4. Reduce the total number of elaborations presented in the Science as a Human Endeavour and Science Understandings strands.
5. Mandate a minimum but achievable number of hours per week spent on developing Science Inquiry Skills, so that teaching and learning programs in schools will achieve a good balance between the three strands, and develop some means of monitoring that this occurs.
6. The document should include an explicit statement that the order of the topics on the Science Understanding strand does not imply a teaching order and that schools should design their courses to suit their particular needs.
7. Increase the proportion of the enabling sciences in the curriculum.
8. Include more rigorous elaborations, so that students gain deeper understandings and greater mastery of skills.
9. Move some content to more suitable year levels, as suggested above, so that sequencing is more appropriate and students can gain deeper understandings and have more opportunities to be challenged and fascinated by Science.
10. Include other elements of sustainability such as recycling and re-using, pollution control and the principles of green chemistry, rather than over-emphasising energy provisions.
11. Incorporate other meaningful 'Big ideas' besides energy and sustainability into the curriculum.
12. In the Inquiry Skills strand, specify that students should perform and evaluate the investigations they design and that Years 7 and 8 students should develop hypotheses.

This curriculum will require energetic, passionate teachers. However, no curriculum can be successfully implemented if the teachers who are required to deliver it and the schools required to implement it do not have the necessary skills and resources. For this reason, in addition to the above modifications to the proposed curriculum, we also strongly recommend that:

13. ACARA ensures that schools receive the resources they need, including laboratory staff, to implement the curriculum. This will be especially important for primary schools.
14. ACARA ensures that all teachers receive sufficient in-depth professional learning to enable them to implement the curriculum with confidence and competence. This includes training teachers in the requisite Science Inquiry Skills, the inquiry-based learning, approach, and background knowledge and understanding. No curriculum can work if the teachers are not provided with sufficient professional learning to teach it!