RESPONSE TO THE 2021 CONSULTATION DRAFT VCE CHEMISTRY STUDY DESIGN

CHEMISTRY EDUCATION ASSOCIATION

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Executive Summary

1. Two hundred and seventy-two members of the Chemistry Education Association met in small groups in July and August of 2021 to discuss the consultation draft of the VCE Chemistry Study Design. Almost all participants were secondary school chemistry teachers, but a small number of university staff from chemistry departments also shared their views.
2. CEA members embraced the reduction in content in Units 3 and 4 and broadly welcomed aspects of the sustainability theme.
3. We agreed that the draft Study Design needs substantial changes before it will be ready for use.
4. We have made 23 recommendations. These are throughout the document in bolded green font on the following areas:
    - The transition from Year 10 to Unit 1, which we feel will be poorly supported and will have implications in student retention through Units 1 – 4.
    - Better incorporation of the context of sustainability into the key knowledge so that this is not simply an "add-on". We also recommend a broader scope than the theme of sustainable industries to include examples from environmental and biochemical sustainability that are relevant to students lives.
    - The sequencing and distribution of key knowledge. We feel that some vital topics are out of sequence, some foundational knowledge is missing entirely and the volume of topics in Units 1 and 2 is significantly higher than Units 3 and 4. As a consequence, the implementation of the Study Design must be staggered to cater for the way topics have moved between Units 1-2 and 3-4 to avoid double-teaching and omission of key chemical concepts.
    - Refining the options for assessment to ensure students can be fairly ranked.

The CEA Committee wish to thank our members who participated in these discussions. We also highly appreciate the opportunity that VCAA provided to contribute to the new Chemistry Study Design.

Background

The Chemistry Education Association was formed in 1977 and is a professional organisation for chemistry teachers. We have approximately 1,200 members and most of these teach chemistry in Victoria at either secondary or tertiary level.
This submission contains a summary of feedback from CEA members to the draft 2023 Chemistry Study Design. Our members were very keen to participate in the discussions. They volunteered to host 25 discussion sessions, and these were attended by 272 secondary school teachers from 164 schools. The geographical and sector breakdown of schools is in the table below. An additional session for the tertiary sector was attended by 15 staff from Deakin, LaTrobe, Monash and Melbourne Universities.

	Government	Non-government
Melbourne metro	69	50
Rural or Regional	22	23

Participation was much higher in this process than in the sessions we ran in 2015 for the introduction of the current Study Design (SD). More than 100 extra teachers have participated in the 2021 consultation process, and we feel that this additional participation has enriched the feedback we summarise in this submission. This level of participation is exceptionally high considering that our members were under COVID lockdown while the sessions were being held and burdened by the stress and higher workload associated with online teaching. Chemistry teachers are clearly very keen to have their say on the draft document.

Our approach

At each session teachers were given the following questions to discuss. They recorded their comments on a Google Jamboard, and the comments were collated and analysed by members of the CEA committee. The discussion questions are listed below, and these form the basis for this submission. The teachers discussed assessment for approximately 15 minutes, followed by Units 1 – 2, then Units 3 – 4 for 30 minutes each.
The discussion questions were:

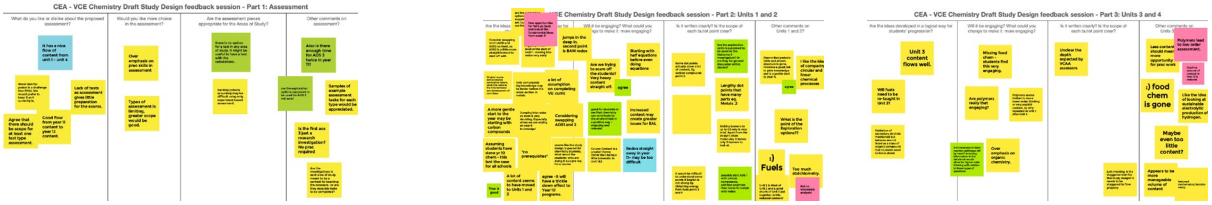
<u>Assessment</u>

- What do you like or dislike about the proposed assessment?
- Would you like more choice in the assessment?
- Are the assessment pieces appropriate for the Areas of Study?

<u>Units 1 – 2 and 3 – 4 (same questions for both year levels)</u>

- Are the ideas developed in a logical way for students' progression?
- Will it be engaging? What could you change to make it more engaging?
- Is it written clearly? Is the scope of each bullet point clear?

The Jamboard results from one of the larger sessions is shown below as a guide to the distribution of teachers' comments. Throughout all the sessions, Unit 1 & 2 provoked considerably more feedback than the Assessment or Unit 3 & 4 questions, and as a result, we will start this report by summarising the discussion of Units 1 & 2, and this forms the bulk of this report.



Typical distribution of comments on Jamboards (left to right): Assessment, Units 1 & 2, Units 3 & 4.

Part A: Responses related to Units 1 and 2 Chemistry

Transition from Year 10

The opening weeks of Unit 1 Chemistry are crucial for students' engagement and success in the discipline and it is vital to have this as welcoming, approachable, and knowledge affirming as possible. We see it as an opportunity to connect to their pre-VCE knowledge and experience a warm embrace from the discipline of chemistry with content that is engaging and in the zone of proximal development for all students.

Removing all content from Unit 1 that is present also in the Years 9 and 10 curriculum will have several consequences on students, teachers, and schools. Most schools currently provide a range of elective science subjects in Year 10 to cater for students' interest and prospective VCE choices. With the introduction of the new SD in 2023, schools will need to rewrite their Year 10 subjects for the second half of this year so that their 2022 offerings will prepare students for the proposed SD. One teacher's comments were:

"In junior science (yrs 7-10) students should be exploring concepts with hands-on open-ended activities that are tied to content rather than direct learning of content for the future."

"this [fundamental] content moves to Year 10 [so it] becomes a pre-requisite for Unit 1 which it should not be."

There was particular concern from teachers in low SES and regional schools, where there is a higher likelihood of teachers teaching VCE chemistry with limited background knowledge in the discipline of chemistry and its pedagogies. Teachers expressed a concern that they would need to spend time early in Year 11 re-teaching ideas from Year 10, while other schools would be marching along with the SD and this would compound students' disadvantages in these schools.

The Periodic Table

The reduced emphasis on the periodic table was a big topic of discussion. A significant proportion of teachers were outraged that there could be any changes on this topic from the current SD. Many thought a more nuanced approach would be appropriate.

One teacher commented that:

"*The periodic table doesn't just provide structure to chemistry, it also provides a structure and theme to the curriculum. Reducing the emphasis on the periodic table doesn't just reduce students' background knowledge for later topics, it removes the theme, the ease of revisiting topics, and reduces the relationships [between] one topic to another."*

Teachers repeatedly commented that the periodic table is also important for later understanding of molecular behaviour like electronegativity, intermolecular forces and covalent bonding. Students who continue with tertiary-level chemistry will meet the periodic table again at all levels of their studies. There are certainly aspects of the "periodic table" in the current SD that are superfluous to the knowledge that is developed at Units 3 and 4, or as one teacher expressed:

"like that subshell config is gone! good-bye Schrodinger! :-)"

Although there was unanimous acknowledgement that all students will have some familiarity with this material from Years 9 and 10, CEA members couldn't agree on the precise way the periodic table and related ideas on the structure of atoms should be included. Perhaps some aspects of the key knowledge from the current SD connected to "the periodic table as an organisational tool" (dot point 4, p13 of the 2016-22 SD) would be appropriate.

We recommend:

- **Retaining aspects of the current periodic table study design dot point in a form that supports students' transition and ensure students have a solid knowledge of its fundamental purpose in chemistry.**

Ordering of topics

It was consistently noted that the students find stoichiometry and redox to be particularly challenging and the SD should pay special attention to the development of these concepts. Teachers described the introduction of redox in Unit 1 as "cursory" and "too early" and that the way it is introduced in the draft document does not provide enough foundation for the topics in Units 3 & 4.
Many teachers suggested reordering Unit 1 so that – after an introductory trip around the periodic table – it should move to carbon compounds and polymers, before moving to an introduction to redox soon after metals and ionic substances. The proposed opening of the course was described as intimidating and difficult by many teachers:

"Are we trying to scare off the students?"

"[it] jump[s] in the deep end. Second point is BAM redox"

Teachers see the separation of "the mole" and "concentration" as a strength of the current SD as it provides a way of revisiting stoichiometry after an opportunity to digest the hardest topic in introductory chemistry.

In the draft document, the first mention of stoichiometry is alongside enthalpy. Each of these on their own are challenging topics. To have them together will increase the cognitive load on students and

will be exceptionally difficult for those who don't have a strong mathematical background. Some comments from teachers were:

"need to do the mole earlier and have it embedded throughout the year"

"I can [see] us as a school skipping forward to do Unit 2 Area of Study 1 BEFORE Unit 1 Area of Study 2"

"obtaining energy from fuels is HARD content, thermochem equations are tricky and they are only year 11's and it's kind of thrown at them."

If students do not meet the challenging topics in appropriate ways in Unit 1 and are required to further develop their understanding throughout the year, this will have consequences for retention through Units 1 & 2 and success in Units 3 & 4.

Moving all titrations to Year 12 also reduces students' opportunity to build their scientific investigation skills and their ability to perform stoichiometric calculations inside of Year 11. Many teachers saw this as a wasted opportunity to utilise the significant equipment and glassware resources they already have in schools across multiple year levels. Furthermore, it reduces opportunities to improve students' careful laboratory skills and understanding of error and precision in analysis. To avoid repetition across year levels, titrations with different levels of difficulty could be staged throughout the course; for example, acid-base titration in Units 1 or 2 and redox titrations in Units 3 or 4.

One of the most consistent observations of the proposed course was the high volume of content in the proposed Unit 2 and the large mathematics demand linked to this material. Teachers feel the volume in Unit 2 of the current SD is also very high, but they quite like some aspects. The current SD has great opportunities for engaging lab classes, solid treatment of concentration and stoichiometry, and a strong theme of water and aqueous chemistry is clear through the Unit.

They commented that the draft Unit 2 contains a significant amount of learning that is foundational for Units 3 & 4 that require considerable classroom attention, and this will be squeezed into Year 11 alongside the revision from Years 9 and 10 that most teachers will need to do. There is clearly a trade-off between the lower volume in Units 3 & 4 and the size of Unit 2, and this appears to have swung too far in favour of the less demanding Year 12.

Along similar lines teachers mentioned several times that important enabling knowledge for some challenging topics was missing or included after it was needed. As examples:

- redox half-and full reactions (dot point 2, Unit 1 AoS 1) are included before the simpler precipitation reactions, and before the broader theory of redox as the transfer of electrons

(dot points 2 and 3, Unit 1 AoS 2). The scope of dot point 2, Unit 1 AoS 1 should be clarified to indicate that ionic and full equations are included.

- weak acids (dot point 5 Unit 2 AoS 2) are before any discussion of equilibrium (dot points 4 – 9 Unit 3, AoS 2
- setting a maximum length of chain of five carbons in Unit 1 provides for a maximum of only five possible branched structural isomers to explore, and this is very limiting for teaching and assessment. This maximum also limits the discussion of fuels with longer chain lengths in Unit 2. One teacher expressed this by saying:

"You can't discuss octane if you can't name it"

In this feedback process, CEA has not completed a full analysis of the sequencing of these challenging topics, but we urge VCAA to engage an experienced chemistry teacher to perform this task, because there are many places where these knowledge gaps are evident even without a thorough examination.

Bonding

In addition to the points discussed above, University staff were particularly concerned that the draft document will not provide a sufficient grounding for incoming students on the fundamentals of bonding. The material that is omitted from the current Study Design (Materials from molecules p14) and the consultation draft (Carbon compounds p22) may appear minimal, but it is very important.

Our biochemistry colleagues have a long-running study on the students' misconceptions on hydrogen bonding that stem from Year 11, where (as an example) students incorrectly believe that every molecule that contains hydrogen and fluorine such can form hydrogen bonds. To address these misconceptions, we would the underlying principle of electronegativity and the periodic trends to clearly stand on its own in the SD, rather than in a densely worded dot point with other topics as it is in the current document. We are also concerned that students will not be aware of the variety of molecules that can hydrogen bond at this stage in Year 11. Including alcohols in this section would be useful for improving students' understanding of hydrogen bonding and would also assist in discussion the use of alcohols as fuels in Unit 2.

Omitting "electron pair repulsion theory" from the discussion of the polarity of covalent molecules in the draft SD gives students no way of correctly understanding why CO_2 is non-polar, as they will not be able to reach this conclusion by looking at the differences in electronegativities alone.

Removing "limitations of representations" from the "representations of molecules" removes the ability to discuss resonance. Connected to this, removing benzene and aromatic molecules from Unit 4 limits the teaching of polystyrene in Unit 1 and Kevlar in Unit 4. We note that this has been retained for the discussion of the properties of metals, and it is not clear why this is removed for the structures of molecules.

We recommend:

- **including titrations in Unit 1 or 2 as well as Units 3 or 4**
- **consider moving enthalpy back to Units 3 or 4.**
- **using a maximum chain length of eight carbons for alkanes in Unit 1, which will then be consistent with units 3 and 4**
- **to the Unit 1, Area of study 1 dot point "the grouping of hydrocarbon compounds into families (alkanes, haloalkanes, alkenes)…", add the alcohol and carboxylic acid as families of hydrocarbons studied**
- **stating explicitly "electron pair repulsion theory" and "limitations of representations", and including a deeper discussion of electronegativity trends in the periodic table in the bonding-relevant dot points in the study design**
- **addressing the uneven volume of key knowledge that is distributed across each unit**
- **VCAA appoint an experienced chemistry teacher to complete a thorough analysis of the sequencing of the enabling key knowledge in (a) Units 1 and 2 of the draft SD and (b) the Victorian Curriculum in Levels 9 & 10, to ensure the enabling knowledge for challenging topics is presented in the best possible order. This is crucial to provide a foundation for all students' success at Units 3 and 4.**

Part B: Response related to Units 3 and 4 Chemistry

Perceived lack of breadth of question types in year 12

In contrast to the draft Units 1 and 2 and the current SD, teachers perceived Units 3 and 4 to be more relaxed and better structured. The perceived reduction in content was often welcomed by teachers, though some noted that the removal of some topics will lead to a dearth of calculation style questions that can be asked in a year 12 exam. Despite a strong engineering and industrial chem influence, there are very few physical chem topics and therefore very little mathematical type questions that could be asked. The removal of mass spectrometry, or using MS in tandem with NMR and IR to determine the structure of an unknown compound, was another example of this.

"Instrumentation works well in the current study design, and kids find it fun to be the "detective" working through the different spectra. It's a shame to remove mass spec for this reason."

Removal of Food chemistry

The decision to remove the bulk of food chemistry led to animated objections from a number of teachers, as could be predicted. A few of these objections were framed around opinions that felt this topic was:
a) popular and more accessible for low-achieving students and
b) the removal of several biochemistry sub-topics made the proposed SD more 'masculine' and 'industrial', leading to an overall reduction in female enrolments.
A number of teachers also stated that students will now have less examples of condensation polymerisation if they don't study proteins, lipids and carbohydrates.

"We like food chem - it is a carrot for some kids, and losing food will lose some kids - it helps with the bio kids..."

"Getting rid of food is fantastic"

"Biochemical molecules should be taught as they will lack key knowledge at university"

However, it should also be said that a sizeable number of teachers agreed with this change, explaining that contexts such as food intolerance, metabolic disorders are better suited for VCE Biology.

Some teachers did point out that green and sustainable chemistry is relevant and applicable to medicinal and pharmaceutical chemistry. Perhaps the incorporation of these topics or contexts could be used to address the perceived lack of biological and medicinal chemistry in the study design without detracting from an overall focus of sustainability. It also connects well to the polymers in Unit 4 as many of these were inspired by biology.

In Victoria, a popular reason to study chemistry is it is a prerequisite for biomedicine and medicine courses. We also currently have a large percentage of chemistry teachers who have biology as their 'first' teaching method, and have studied more biology and biomedicine than chemistry at university. Providing more sustainability-relevant biochemical contexts will give these teachers more insight into the curriculum content and enable them to make it more engaging for their students.

"A lot of young teachers will 'get' sustainability, because they have been at uni where sustainability has been a big focus of their undergraduate courses. But this has NOT been a big part of the undergraduate study of a lot of our teachers. A lot of new knowledge to learn - but okay with that."

We recommend:

- **Re-address the perceived imbalance of biochemistry and green/sustainable chemistry in the study design, particularly in units 3 and 4. This can be achieved by introducing or re-introducing elements of biochemistry that support the over-arching theme of sustainability, without returning food chemistry to the study design.**

Ordering of topics

Whilst not as critical compared to Units 1 and 2, there again was an overall general comment from teachers that the sequence across Units 3 and 4 didn't "flow". Specific comments/concerns relating to an individual dot point or Area of Study, which we agree needs considerable attention, included:

- The core learning of polymers was read as being repeated in Units 1 and 4 by teachers. This was particularly questioned in light of other topics being removed due to over-crowding of year 12.
- In Unit 3, Area of Study 1, the dot point states for "the comparison of fossil fuels and biofuel combustion with galvanic cells and fuel cells for sustainably supplying useful energy...", but fossil fuels and biofuels had not been mentioned as yet in Unit 3.
- In Unit 4, the oxidation of secondary alcohols is stated as a reaction of investigation, but aldehydes and ketones are not in the list of organic compound types. Equally, secondary amides and the condensation reactions to form them are not included, but polyamides are included later in Unit 4 polymers.
- Unit 4, Area of Study 1 was identified as having too much focus on sustainability. If the implementation is not staggered, teachers will not have had sufficient professional learning to adequately deliver this Area of Study so soon in the new SD.
- Unit 3, Area of Study 1 had 7 dot points, but Unit 3, Area of Study 2 had 16 dot points; a few teachers queried if this mean Area of Study 2 would be weighted more in the exam.

- By excluding enzyme mechanism, it leaves little room for students to describe chemically how temperature and pH actually affects activity. Teachers either suggested this should either be worded better or removed entirely.

"enzymes as protein catalysts - it just kind seems to float on its own - without food being there, what is the point of it; also it "controls specific biochem reactions" - what are these, should there be specific ones? - very out of context without proteins"

- The dot point 'Chemical society' in Unit 4, Area of Study 2 was perceived as being *very* broad, and easily misinterpreted. For instance, a number of teachers inferred from the phrase "...in isolation, or within a mixture" that chromatography and HPLC would be in the study design, but it is not explicitly stated.

Part C: Response related to Assessment

Given the large response from teachers from a breadth of different schools, feedback on the proposed assessment structure touched on a number of different aspects. Several changes were well received and are supported by the CEA; a 50% exam, a greater range of assessments at Units 1 and 2; increased time dedicated to practical and assessment tasks; and the clearer explanation of methodology and key definitions. The remainder of this section will focus on suggested changes to the assessment design.

Word limit of Scientific Poster

Teachers appreciated the clear poster template provided as well as more explanation about each section of the poster. However, several teachers were concerned with the reduced word limit.

"This will be difficult for students to be concise, accurate and thorough enough. It will be difficult to rank the students at the top end of spectrum. i.e., 45 – 50"

"The focus should be on a report not a chopped down summarized poster with no real purpose"

"600 words for a poster is quite limiting but we are still expecting 10 hours of work - can we have a greater word limit for this?? Why have you limited it to 600 words? Where are the expected words meant to be? Discussion/Conclusion or..?? Does more go into the Log book instead?"

The study design provides significantly more information on what students should be expected to say in the scientific poster, which is appreciated. However, as many teachers noted, it will be considerably harder to rank students who are expected to 'say more with less'.

We recommend:

- **Increasing the word limit of the poster from 600 words to 800 words**

Choice and Applicability of School-assessed coursework (SAC) task types

The significant shift in what types of SAC tasks could be set was not well-received by a significant proportion of teachers. The types of assessments in Unit 3 and 4 were seen as "limiting", that they "did not cater to all learners", and the first three in particular were seen as too similar to each other. A couple of teachers went so far as to say that the proposed assessments did not seem to test 'content knowledge' at all. The lack of flexibility was criticised, as having to do each SAC type once (and only once) was seen as stymying choice.

"We really like the ones (SACs) that we have in the current study design! Why not select only one from those?"

However, much of this can perhaps be linked to the prevailing belief amongst some teachers that SACs should in some way be modelling the external examination. A number of teachers expressed surprise and dismay that a 'structured questions' type SAC task had been removed.

"disadvantaged students find helpful to have more practise at this (structured questions)"
"It might be useful to have a test with the calculations"

"The assessment seems too restrictive and inflexible. Responding to structured questions is an essential skill."

"SACs should reflect the exam in some way, and in the study design proposed either the exam will be radically different or the SACs won't reflect the exam"

The CEA agree with VCAA in principle that SAC tasks should be assessing different skills to those that are normally utilised in an exam. But from the responses, we can see that teachers still appreciate being able to set a SAC (or multiple SACs across Units 3 and 4) that prepare students for examination-type questions. A 'middle position' might be to demonstrate to teachers, through implementation workshops, how the examination will *also* be changing, so that teachers can see that these different SAC types do also (at least in a minimal way) prepare students for the examination.

Teachers also correctly identified that a large proportion of students will do differently in experimental and/or 'research report' type SACs, compared to exam/test type SACs. These teachers shared a concern then that how they rank their students could vary significantly to how the students rank in the external examination. A teacher from a school with a large cohort expressed concern for how they could be expected to authentically rank students if they could not set a SAC under test conditions at the same time.

Teachers asked for exemplars of the assessment types, guidance on performance descriptors and assessment rubrics, and clarification on what type of case studies could be incorporated.

"Need more resources to be able to tackle the different assessment types, sample articles etc."

"Can we have examples of the types of assessments in each dot point in Unit 3 and 4"

"Expand on the assessment tasks for Unit 3 & 4, what are the expectations and criteria."

We recommend:

- **A greater breadth of assessment types should be offered, whilst maintaining that each type can only be done once (across units 3 and 4).**
- **Exemplars for each SAC type should be provided, including rubrics and low/middle/high annotated samples, to support teachers who are now required to implement these new SAC assessment types.**
- **These exemplars should also demonstrate how some (but not all) of these SAC types could incorporate some 'structured questions' or calculation-style questions, so teachers feel that these in some way are preparing students for how questions will be framed in the examination.**

Part D: Overall Recommendations for Study Design

The CEA supports many aspects of the proposed SD, in particular the lighter Units 3 and 4, plenty of choice of assessments in Units 1 and 2, the inclusion of sustainability across the study design, and the decreased weighting of the exam. However, we submit that the course cannot be introduced to schools in this draft form without addressing the several significant concerns emphasised by teachers.

Staggered implementation

Unanimously, teachers have requested that implementation be staggered over 2023 and 2024. There have been many reasons given for this, including:

- As highlighted by several teachers, with several energy and calculation-based questions moving from Unit 3 to Unit 1 and 2, Year 11 students in 2022 will miss some topics entirely and other topics may be repeated unnecessarily. Therefore, what could be assessed in an external examination in 2023 could be very limited.
- The focus on sustainability and many other contexts across units 1 to 4, that will be new to teachers, will mean that significant professional learning activities will be needed to develop the course, not least to consider how this focus on sustainability will be *assessed* in the external examination.
- There is significant difficulty developing resources in time for both year levels. Teachers in the first year could develop their knowledge and capacity to incorporate this into their pedagogical approach in 2023 with their year 11s, but to do at the same time with their year 12s who will be facing an external examination will lead to an unnecessary burden on teachers and students.
- Some teachers are currently teaching combined Year 11 and 12 classes, implementing the changes all together would be a massive amount of preparation and would greatly increase workload.
- The new SAC assessment types, whilst themselves not negatively viewed by teachers, will mean that students will need direction in Year 11 with new assessment tasks. They need to be taught the necessary skills in preparation for the assessed tasks in Year 12.

We recommend:

- **Units 1 and 2 should be implemented in 2023, and Units 3 and 4 should be implemented in 2024.**

Integration of sustainable chemistry and the circular economy across the Study Design

The integration of sustainable chemistry and the circular economy represents a major change of focus with this SD. Teachers were largely supportive of this progressive, future-focussed change, and most criticisms regarding this addition were in fact related to topics that had been displaced (such as food chemistry). That said, a few teachers felt that the whole-study design incorporation did seem a bit 'heavy handed'.

"Is too much sustainability/green chemistry going to be a 'groan point' - "here we go again"?!"

However, the near unanimous view by teachers is that teachers do not have the expertise to inspire and be passionate about the topics.

"Green chemistry and sustainability appears in a number of places in the new study design. More specific guidance as to the depth, breadth and content of green chemistry will be necessary to ensure that there is equitable interpretation across all schools"

Put simply, the SD presented here is not the chemistry the vast majority of teachers have learned at school or at university. Teachers could therefore 'fall back' to relying on students rote learning from textbooks, and this lack of engagement could be detrimental to students.

Whilst a whole SD focus on sustainability is important for the future stability and security of our society, students being taught by disengaged teachers may in fact lead to the opposite intended impact; a cohort of students choosing to not engage with one of most important decisions impacting their future lives.

We recommend:

- **Significant, properly funded and highly targeted professional learning programs be a core focus of the implementation in Units 1 and 2 in 2023, and Units 3 and 4 in 2024.**
- **These programs should also be supported by a comprehensive 'Advice for teachers' website and package of resources, that clearly demonstrate how the focus on sustainability across many Units 1-4 topics can be engaging and motivating, but also can be assessed equitably in school assessment tasks and examination questions.**
- **Careful re-positioning of sustainability concepts *within* the dot points, so teachers can clearly see how and where they relate to the core chemistry knowledge and are not seen as 'add-on' dot points that are unlikely to be assessed in an examination.**
- **Careful rewriting of the sustainability- and circular-economy focussed dot points so that a broader range of non-industrial chemistry is represented in key knowledge in order to better represent the central contribution chemistry makes, and must continue to make, to**

society, and to better represent the interests and skills of all chemistry students, inclusive of gender, cultural and socio-economic background.

Chemical typos and other errors in the proposed SD

Our teachers also noticed a number of chemical typos and errors, that should be addressed in the next draft of the SD.

We strongly recommend:

- **Replacing "cell phones" with "mobile phones" (p 38).**
- **Replacing poly(ethanol) with poly(ethenol) (p 41).**
- **Removing "(PET)" (p41). PET is the abbreviation for polyethylene terephthalate, not for polyester. Polyethylene terephthalate is a member of the polyester family.**
- **Removing "quantitative" from IR spectroscopy (p42). This text is also included in the current SD but is not currently taught or examined and we believe that it is inadvertently in both documents.**
- **Replacing "molecules" with "molecular substances" (Carbon compounds, dot point 3 p22). Melting/boiling points and conductivity are measured properties of the substance, not of the molecule. Students have trouble moving between the symbolic, macroscopic, and sub-microscopic representations of molecules and it's important to be precise with these terms.**