VCE Chemistry 2017–2023

School-based assessment report

This report is based on the School-based Assessment Audit and VCAA statistical data.

All official communications regarding the *Victorian Certificate of Education (VCE) Chemistry Study Design* are provided in the *VCAA Bulletin*. It is recommended that teachers individually subscribe to the *VCAA Bulletin* to receive updated information regarding the study. The *VCE and VCAL Administrative Handbook* and *Important Administrative Dates* are published on the Administration page of the VCAA website.

General comments

Responses to the School-based Assessment Audit for VCE Chemistry indicate that most audited schools have made a successful transition to the reaccredited *VCE Chemistry* *Study Design 2017–3* School-based assessment enhances the validity of student assessment by providing opportunities for non-routine and open-ended Chemistry contexts and applications to be explored in greater depth and breadth than is possible in an examination.

The audit process

The School-based Assessment Audit enables the VCAA to check that School-assessed Coursework (SAC) tasks are compliant with the VCE assessment principles and the requirements of the *VCE Chemistry Study Design*.

Schools are advised to prepare their responses to the study-specific audit questionnaire using the PDF available on VASS before they begin to complete the audit online. Some questions contained in the audit questionnaire may require consultation with school leadership or other colleagues: for example, locating the school provider number or details of the school redemption policy.

Schools should ensure that all requested materials are submitted for the audit. Materials potentially required for submission are listed in the *VCE and VCAL Administrative Handbook*. If materials are not submitted as requested, a judgment cannot be reached by the Audit Panel as to whether the school concerned has satisfied VCAA requirements for school-based assessment.

The first stage of the audit requires schools to complete a study-specific audit questionnaire by providing information about assessment planning, timelines, resources, the types of assessment tasks set and the conditions under which students sit the tasks. Most audited schools designed and used tasks that met the requirements of the reaccredited study design and the VCE assessment principles. However, some schools proceeded to the second stage of the audit process due to issues including the use of multiple-choice items in SAC tasks, particularly in ‘structured questions’ or added to the end of practical reports, and the use of unmodified materials available in the public domain, such as the use of purchased commercial materials, textbook practical activities, VCAA past examination questions and materials sourced from universities and specialist science centres.

For each outcome, the audit questionnaire asked what the students are required to do for the assessment task/s as well as the conditions under which the task/s are conducted. For a small number of responses, further evidence was requested about the task/s since it was not clear whether they met the definition of the task type. Further advice about the scope of the assessment tasks can be found in the online [*VCE Chemistry Advice for teachers*](https://www.vcaa.vic.edu.au/curriculum/vce/vce-study-designs/chemistry/advice-for-teachers/Pages/Index.aspx).

Most schools reported that the questionnaire was a useful undertaking as it provided an opportunity to review their practice considering the new study design and helped ensure there was a good overview of the whole unit in terms of the relationship between key knowledge and key science skills.

Assessment planning

All schools provided an assessment timetable to students at the beginning of the school year, or occasionally during the previous year’s orientation program, to assist them in planning for assessment. In many schools, SAC tasks were used for both formative and summative purposes.

Prior to each SAC task being undertaken, students should be given a clear and accurate statement of:

* **the outcome being assessed**
* **the selected task type**
* **the requirements and conditions of the task**
* **the contribution of the task to the final outcome score.**

Many schools provided students with the assessment rubrics that would be used to assess the SAC task prior to the task being undertaken. For some outcomes, multiple tasks had been selected. In this case, schools are advised to consider the length of some tasks so that the total assessment time for the outcome is not excessive.

Although most teachers reported using VCAA performance descriptors to assess student work, these are not mandated and, in some cases, school-developed marking schemes may be more appropriate.

Task development

The audit has shown that most teachers have paid close attention to both the key knowledge and the key skills in the reaccredited study design and have designed content-aligned assessment tasks.

Despite a broader range of assessment task types being offered across Units 3 and 4 of the reaccredited study design, most schools adopted a conventional approach to assessment with very little uptake of the newer task types. Schools are advised to refer to the online [*VCE Chemistry Advice for teachers*](https://www.vcaa.vic.edu.au/curriculum/vce/vce-study-designs/chemistry/advice-for-teachers/Pages/Index.aspx) that outlines different approaches to assessment tasks. This publication also includes advice about developing School-assessed Coursework tasks, the nature of scientific inquiry, sample teaching and learning activities and programs, elaborations of assessment tasks, and examples of performance descriptors.

Overall, SAC tasks addressed a wide range of key knowledge from the reaccredited study design and required students to demonstrate relevant key science skills. Many schools described how assessment tasks were developed to ensure that higher order/more complex questions were included and weighted appropriately. Reference was made to balanced assessment of problem-solving, theoretical and practical laboratory skills, use of a range of different tasks types, Bloom’s taxonomy, and inclusion of questions of varying cognitive demand, from questions requiring simple recall ranging through to analysis, evaluation, synthesis and application questions involving unfamiliar scenarios. Teachers also used multiple-choice questions, diagram-based questions, scaffolded questions, open-ended questions, tasks based on designing chemical pathways, and single-step and multi-step tasks to differentiate student performance. Mathematical applications were also included through graphical construction and analysis, and data evaluation including explanations of discrepancies in provided data. In some schools, the VCE assessment principle of balance was applied through the deliberate selection of different task types across Units 3 and 4.

Most audited schools had used unmodified commercially produced materials, materials from teacher networks, and/or past VCAA examination questions to develop SAC tasks. Although all schools checked these materials against the requirements of the *VCE Chemistry Study Design,* schools are reminded that any materials available in the public domain must be significantly modified to minimise the risk that authentication issues will arise. It is not sufficient that these tasks are used in an unmodified form under test conditions since students may have accessed them through sources external to the school. Tasks developed collaboratively with teachers from other schools must also be modified so that the tasks are unique to each school. In cases where it was not clear to what extent publicly available materials had been modified, schools were asked to provide these original materials alongside their own modified SAC tasks as further evidence. Schools are advised that modifying previous years’ tasks may be insufficient to ensure student work can be authenticated as contexts may be too specific to develop alternative questions. Modification of publicly available tasks may be possible through mapping of key knowledge and key science skills and then using other knowledge/skills as the basis of new questions/tasks.

A significant audit issue related to over-assessment. Although all outcomes in each area of study must be met by students in order to be awarded an ‘S’ for a unit, a representative section of the set of outcomes is enough as the basis for SAC task development. Many assessment tasks were overly lengthy or tried to encompass every aspect of the key knowledge and key skills in a single task.

A further issue related to schools not meeting the VCE assessment principle of ‘balance’. While it is admirable that schools emphasise the practical aspects of the course, selecting ‘a report of a student/laboratory investigation’ for most outcomes, or similarly selecting tasks that were adapted to become examination mimics, does not allow students to demonstrate a range of knowledge and skills in different ways. Further, the use of multiple-choice questions is not appropriate in either the ‘analysis and evaluation of stimulus material’, ‘response to a set of structured questions’ or ‘data analysis’ tasks. For the latter task, it is expected that students would graph primary or secondary data prior to analysing the data and stating relevant generalisations and conclusions that can be drawn from the data.

A few audited schools did not return SAC tasks to students as they intended to modify these for use in the following year. Returning SAC tasks to students enables valuable feedback to be provided as well as enabling students to refer to the tasks for examination revision purposes. Schools are reminded that SAC tasks do not need to be stored at the school after the publication of study scores at the end of the academic year. However, students/schools should retain SAC tasks until the end of the academic year.

Although all SAC tasks were fully supervised, material requirements varied across schools. Some schools required that students bring in logbooks to refer to generated data in their SAC task responses, while other schools used data and stimulus material previously unseen by students as the basis for SAC tasks. Most SAC tasks allowed students to access materials as per external examination specifications. Sometimes students were also instructed as to what materials could not be used during SAC tasks; usually blank sheet/s of paper and mobile phones were not permitted.

International schools offering VCE Chemistry work in conjunction with Victorian school partners. Safety precautions normally undertaken in Australian schools are applied in international schools, with local protocols also being applied; for example, one school specified the use of green chemistry principles due to the limited capacity for safe waste disposal in the country.

The VCAA performance descriptors, or modified versions thereof, provided the assessment framework for many assessment tasks. Schools are reminded that these performance descriptors are not mandatory. For tasks involving a series of questions, a marking scheme is more appropriate.

Authentication

Schools need to be aware of the authentication requirements set out in the *VCE and VCAL Administrative Handbook*. Any work set over an extended period should include a process for authentication of student work. Most schools provided details about the procedure used to authenticate student work that included how logbooks were used by students and monitored by the teacher. It is recommended that attention is paid to authentication for Unit 4 Outcome 3 and that as much work as possible is observed, completed in class, initialled and dated by the teacher on a regular basis.

All schools audited indicated that SAC tasks were completed under teacher supervision, making authentication of student work less problematic. Where SAC tasks involved preparatory data generation and/or laboratory work (such as ‘annotations of at least two practical activities from a practical logbook’ or ‘a report of a student/laboratory investigation’), students were often required to keep their logbooks at school, ensuring their work could be authenticated.

Schools with multiple classes and more than one teacher indicated marking consistency was achieved by using a prepared answer sheet, discussion and/or cross-marking. For schools with only one Chemistry class, marking validation was often achieved by working with another Chemistry teacher, either within the school or at a different school, to mark a sample of ‘top’, middle’ and ‘low’ student work. These practices are important to ensure an accurate student rank order is attained.

All audited schools had in place thorough and appropriate processes related to authentication of student work and student redemption of an ‘N’ outcome.

Practical work

Practical work is an important part of the *VCE Chemistry Study Design* and was undertaken regularly in all audited schools, mostly weekly in a ‘double lesson’ and sometimes fortnightly. It is generally managed in conjunction with laboratory staff, adhering to risk registers for chemical use and applicable safety data sheets. Many experiments are already familiar to teachers from the previous study design and were used as the basis of some assessment tasks. Practical work is carried out in the form of teacher demonstrations, laboratory experiments conducted by the students individually, in pairs or small groups, and modelling. No reports were made of the use of virtual laboratories or simulations. Logbooks are used extensively.

Generally schools are adequately resourced with chemicals, equipment and appropriate facilities to meet students’ practical work needs, including wet and dry areas, fume hoods, benches, and desk spaces. In cases where audited schools reported having no laboratory facilities, chemicals or laboratory staff, use of another local school’s laboratory was organised in addition to an extended workshop presented by a local tertiary facility. Some practical work requiring minimal equipment was conducted on the school site – for example, a lemon galvanic cell and a rate of fermentation reaction – as well as a number of second-hand data exercises, supplemented with video clips and DVD material being used: for example, energy from fuels and the determination of the molar volume of a gas. One remote audited school selected practical activities based on their suitability for both home and laboratory environments, with no potentially harmful chemicals or procedures being included in practical work, and students being instructed how to modify experiments undertaken at home.

In a few schools, students are given pre-reading regarding a practical activity, including pre-lab questions, which serve as formative assessment prior to the SAC task being undertaken.

Field work

Although fieldwork was not commonly undertaken in Unit 3, relevant activities that supported learning and preceded SAC tasks included a visit to a local silversmith to observe the plating of copper with silver for use in jewellery, a ‘round robin’ of activities related to chemical processes offered by a local university, and a visit to a diesel electricity plant in an international school to reinforce theory related to the use of diesel as a fuel. A few schools reported preferential allocation to laboratory resources rather than outsourced activities while a few schools reported planned fieldwork related to Unit 4, particularly with respect to instrumentation involving the use of analytical instruments specified in the study design, ester synthesis, and food production and/or analysis. Some of the Victorian schools were reminded that these materials are available in the public domain and must be modified significantly prior to use as a SAC task, despite students generating their own data. Several schools also arranged guest speakers: for example, an environmental chemist to discuss collection of organic pollutants and how they are analysed with specific reference to the analytical techniques specified in the study design.

Student-designed practical investigation

The Unit 4 Outcome 3 student practical investigation can be undertaken at any time across Units 3 and/or 4. Schools were almost evenly distributed as to when the investigation was undertaken, as shown the following graph:

The audit findings also showed that in almost 60 per cent of schools, the student investigation was based
on Unit 3. Little choice was provided to students, as shown in the graph below:

This reflects both prior practice in content choice, since Unit 4 Outcome 2 is new content compared with the previous study design, as well as there having been no assessment task in the previous design that offered student topic choice. Nevertheless, in some schools students developed questions that linked to both Unit 3 and Unit 4 content: for example, ‘How does the quantity of energy that rice and corn crackers provide through cellular respiration compare with their experimental heat of combustion?’ It is anticipated that as schools become more familiar with the new study design, a greater choice of student topics for investigation will be undertaken.

All audited schools provided appropriate timelines for staging the various aspects of the investigation, from design of the investigation through to data analysis and evaluation, and the presentation of findings in a scientific poster. Several audited schools provided students with a booklet to scaffold student investigation planning and progress as an adjunct to the student logbook and/or to provide an overview of the scientific investigation process to be followed. In all schools, the same assessment rubric was used for all students, irrespective of the specific investigation question, to ensure comparability of task scope and demand. Schools must therefore ensure that there is comparability of student investigation questions so that all students can achieve at the highest levels of performance.

Each student should be assessed on their individual capacity to design, undertake and report on an investigation. For many chemistry experiments, it may not be practicable for each student to undertake a unique investigation, particularly in cases where direct readings are recorded: for example, in titrations. In these cases, it is an acceptable practice for students to work in pairs or threes to generate data after they have been assessed on their individual capacity to design an investigation.

For large classes and/or multiple classes, schools generally limited choice to a few areas; for example, one school restricted student choice of investigation to electrochemistry in order to manage physical and human resources. Other schools provided a general question for students to refine into more specific investigable questions: for example, ‘How can the amount of energy lost in a tin can calorimeter be minimised?’ Schools adopting this restricted topic approach must provide enough scope within the topic to ensure that student investigations are not simply confirmation type activities; for example, ‘Does the concentration of the electrolyte in an electrolytic cell have a determining effect on the mass of the metal deposited at the cathode?’ would be better phrased as ‘How is the mass of the metal deposited at the cathode affected by the concentration of electrolyte in an electrolytic cell?’ so that a relationship, rather than a ‘yes’ or ‘no’ response, can be established. More importantly, the answer to this question can be readily predicted using application of chemical understanding of stoichiometry and Faraday’s Laws. Student investigations should have an unknown answer, so in this case a more appropriate question may have been ‘How well does copper plate onto different metals?’ Confusion between the terms ‘affect’ and ‘effect’ were common in student questions. In general, questions could be framed as ‘How does X affect Y?’, ‘How is Y affected by X?’, or ‘What is the effect of X on Y?’

A number of audited schools permitted investigation questions that could be answered by referring to published data tables – for example, ‘Do almonds, peanuts or cashews release the most energy?’ – or where values could be checked on the back of packaging, such as comparing the energy content of a product and its low sugar equivalent. These questions could appropriately be used as the basis for developing laboratory skills as the first stage of a coupled experiment so that students can later develop their own questions and design their own experiments: for example, in comparing the energy content of almonds grown under different environmental conditions or investigating the relative energy contributions of different types of biscuits in a package of assorted biscuits. Schools should also note that questions such ‘How accurate is the value for the energy content of chocolate biscuits reported on the packaging?’ are unlikely to reveal incorrect commercial reporting of energy content, and that commercial determination of energy content will be more accurate than values determined using school laboratory apparatus. Similarly, Vitamin C content as determined by a titration is not as accurate as instrumental determinations, so confirmation of labelled Vitamin C content is not appropriate. A relevant approach would be to investigate questions with unpredictable outcomes: for example, ‘How does the Vitamin C content of different species of lemons compare?’, or to investigate the effects of different storage options on the Vitamin C content of a selected citrus fruit. A further consideration for schools is that although Vitamin C can be analysed through both titrations and colorimetry, colorimetry relates to Unit 2 study design content and is therefore not a valid technique to use for the student-designed investigation in Unit 4.

Published values for energy content or other chemical quantities may be used as a comparison with unprocessed or non-commercial products. For example, ‘How does the energy content of commercial duck fat compare with duck fat collected after a duck has been roasted?’ would be an appropriate student investigation question since it requires the generation of primary data.

Schools are reminded that experiments involving foods should comply with health and safety requirements. This particularly relates to experiments comparing energy content of different nuts or nut oils that pose significant anaphylactic risks for some students. Experiments involving foods that involve testing over a prolonged time must also be conducted safely to avoid health risks associated with microbial growth and decay; for example, investigations into the effectiveness of lemon juice acting as an antioxidant in slowing the browning of bananas and apples need to be appropriately covered, stored and disposed.

Schools should provide advice to students prior to conducting any experiment where the variables have not been sufficiently controlled. Questions such as ‘What is the optimum time to electroplate a nail?’ may be used as a generic class question but cannot reasonably be expected to be answered in a meaningful way in the given time allocated to this area of study by an individual student.

Schools should ensure that there is a purpose to proposed student investigations. For example, it is unclear as to the importance of a question such as ‘Is there a difference in density of wholemeal versus plain bread?’ Students should include a reason as to why their proposed investigation is important in the ‘introduction’ section of their scientific poster.

Care should be taken to ensure that questions are directly linked to chemistry knowledge and skills. Questions such as ‘Would ethanol or methanol be better value for money?’ are generic and require that the term ‘value’ is defined. A more specific chemistry question in this case would be ‘Would ethanol or methanol boil water faster?’

Schools are advised that assessment of a student’s capacity to design experiments may identify that proposed investigations are not practicable, or safe, to run. In such cases, students may be directed to investigate an alternative research question and subsequent assessment will be based on the alternative investigation. The original assessment of experimental design will hold.

VCAA reports

Several VCAA reports are available to assist in informing teaching and assessment practices. Schools used Examination Reports, Statistical Moderation Reports and School-assessed Coursework Reports to improve the learning outcomes of students and to create assessment tasks that met the VCE assessment principles. The reports were used at the individual teacher level and, in many cases, at the departmental, faculty and/or school level.

Specific information

Unit 3: How can chemical processes be designed to optimise efficiency?

For Unit 3 the student is required to demonstrate the achievement of two outcomes. In addition, students may undertake the Unit 4 Outcome 3 task (the design and undertaking of a practical investigation related to energy, equilibrium, organic chemistry and/or good, and the presentation of methodologies, findings and conclusions is a scientific poster) across Units 3 and/or 4.

Area of Study 1: What are the options for energy production?

Only one task type, from a set of four, may be selected in school-based assessment for Outcome 1. The most commonly selected tasks for Outcome 1 were based on laboratory activities and reflected prior practice, as shown in the following graph:

Some schools proceeded to the next stage of the audit process because more than one task had been selected or two task types were combined into a single assessment task.

The Outcome 1 laboratory investigation task was most often based on the measurement of the heat content of fuels. Many schools used a commercially produced 170-minute assessment task. Materials available in the public domain must be checked for compliance with the study design, including content alignment and prescribed time and/or word limits. Further evidence from these schools required consideration as to which parts of the original task could be used for pre-assessment, which parts could be used as formative assessment and how the parts to be used as the SAC task would be modified so that the task was unique to the school.

The focus of the ‘comparison of two electricity-generating cells’ SAC task is on the *comparison* of two cells. Some schools proceeded to the next stage of the audit because they had developed an invalid task involving separate consideration of two different cells, with no comparisons being made. In other cases, an electricity-generating cell was compared with an electrolytic cell, which is also invalid since electrolysis relates to Unit 3 Outcome 2. In some schools, the comparison task was supplemented with the inclusion of a set of ‘structured questions’, generally drawn from past VCAA examination papers. While this is a worthy skill-building activity, the task is invalid since only one of the nominated task types in the study design must be selected. Such tests are more appropriately run as in-class tasks, feeding into the school’s Indicative Grade determination, and used for formative assessment purposes.

The experiments on which the SAC tasks were based were all teacher-driven, but they often provided inspiration for many of the Unit 4 Outcome 3 student-designed investigation tasks.

The newer assessment task types were not taken up by many schools. No schools selected the reflective learning journal task, and only 13 per cent of audited schools created SAC tasks based on the analysis and evaluation of stimulus material. The most innovative of these tapped into a YouTube clip that students watched in class before addressing a set of questions. Other schools set tasks involving research and note-taking on issues relating to energy prior to students sitting for a 50-minute written task. These SAC tasks were challenging and relevant and, given the rapid changes occurring in the current global energy markets, should also be easy to adapt from year to year with updated materials.

Area of Study 2: How can the yield of a chemical product be optimised?

For Outcome 2, schools may select one or more from a set of eight task types. Commonly schools chose tasks that were familiar from the previous study design. Almost 68 per cent of schools chose one assessment task, 28 per cent chose two assessment tasks and just over 4 per cent chose three assessment tasks for the outcome. The choice of multiple assessment tasks should consider the demands on students with respect to the VCE assessment principle of efficiency. Many schools choosing multiple tasks exceeded the study design guidelines that tasks should not exceed 50 minutes each.

Annotations of at least two practical activities and a response to structured questions were the most popular task types, as shown in the following graph (note that total percentages for the set of tasks in each outcome exceed 100 per cent as some schools undertook multiple tasks).

Task types selected for Outcome 2 were almost evenly split: students either completed a practical activity related to reaction rates and were then asked to respond to a set of questions associated with these reactions, or they were given what was essentially a test, or a response to a set of structured questions, drawn in most instances from past VCAA examination questions related to the rate-yield conflict, electrolysis and batteries. A major audit concern in the use of these two task types arose when materials available in the public domain, including published materials and past VCAA examination questions, were used in an unmodified form.

A notable exception to these two well-established approaches was the investigation of the Betts electrolytic process (an analysis of an unfamiliar chemical manufacturing process) for the purification of lead from bullion.

*(If conducted during Unit 3):* Unit 4 Outcome 3 (Area of Study 3: practical investigation)

Most schools based this assessment task on Unit 3 content, with many undertaking this outcome during
Unit 3 while the relevant chemical concepts were still fresh in students’ minds.

Different approaches were used in supporting students to develop their own questions. Most teachers set
a general question or problem-solving scenario, such as ‘How can you calculate the energy content of a marshmallow if there is no nutritional information on the packet?’, from which students developed a proposed investigation method. Another common approach was to offer students a choice of investigation topics related to fuels or galvanic cells.

Schools are advised to check the [VCE Chemistry *Advice for teachers*](https://www.vcaa.vic.edu.au/curriculum/vce/vce-study-designs/chemistry/advice-for-teachers/Pages/Index.aspx), which contains an extensive list of possible topics. However, schools are reminded that since these resources are available in the public domain, they must be modified prior to use as an assessment task.

Schools that undertook this outcome during Unit 3 used it for formative and summative purposes, particularly in developing students’ capacity to design their own investigations and to critique the investigations of others, including published research.

Unit 4: How are organic compounds categorised, analysed and used?

For Unit 4, students are required to demonstrate the achievement of three Outcomes. Outcome 1 allows a choice of at least one task from a set of six task options, while Outcome 2 allows a choice of one task from
a set of four task options. Although the Unit 4 Outcome 3 task may be undertaken across Units 3 and/or 4, over half of the audited schools undertook the Outcome 3 task before the start of Unit 4. Practical work averaged 4.5 hours for Area of Study 1 and 4 hours for Area of Study 2. The student investigation for Outcome 3 was staged on average over 9.5 hours.

Area of Study 1: How can the diversity of carbon compounds be explained and categorised?

Over 65 per cent of schools used only one task to assess Outcome 1, nearly 30 per cent used two tasks
to assess the outcome, and a small number of schools used three or more tasks to assess the outcome. Schools are reminded that care should be taken not to over-assess students.

A number of schools proceeded to the second stage of the audit because of multiple tasks, or sometimes
a single task, that well exceeded time and/or word limits for SAC tasks as specified in the study design.

Selection of assessment tasks reflected assessment practice in the previous study design, and the desire to provide an examination-style experience for students, with a ‘response to structured questions’ being chosen by almost 80 per cent of audited schools, as shown in the following graph:

Almost 15 per cent of audited schools used external providers and laboratories to develop assessment tasks for Outcome 1. Schools are reminded that while hands-on experience in organic synthesis and instrumental analysis provides authentic learning opportunities, all materials sourced from these providers must be modified to create assessment tasks that are unique to the school. Results from these outsourced practical activities can be used to construct several assessment task types as specified in the *VCE Chemistry Study Design*.

Typical tasks developed by schools for this outcome were based on experiments related to esters, organic structural modelling, and tests. Schools are reminded that a ‘test’ is not the same as a ‘response to structured questions’. A description of ‘a response to set of structured questions’ can be found in the online *VCE Chemistry Advice for teachers* as follows:

‘The teacher should develop a set of multi-part questions that target both key knowledge and key skills related to a chemical theme. The questions should be scaffolded to enable demonstration of performance at the highest levels, while providing access at each part for students to be able to provide a response independent of prior responses. This task lends itself particularly well to selecting material related to a contemporary issue in chemistry and/or providing sets of questions that link theory and practice.’

A number of schools proceeded to the next stage of the audit due to tasks not being valid: for example, by including multiple-choice questions either as part of the ‘structured questions’ task or added to other task types.

Examples of more innovative tasks for this outcome included students:

* making 3-D models of organic molecules and photographing their work in class; these were later edited as a summary SAC task to illustrate the difference in organic isomerism
* using their logbook records of completed experimental work to design reaction pathways for unfamiliar chemical scenarios
* analysing a complex spectral data scenario with a carefully structured set of prompts for each type of spectrum
* responding to a dilemma (e.g. ‘A student has been making an ester in class. They did not clean up properly and have left unlabelled beakers behind. Your task is to identify these’) followed by a series of prompts to assist the students to ‘solve’ the dilemma
* problem-solving to ‘identify and correct the mistakes made by an imaginary student in a summary poster of organic reaction pathways and instrumental analysis
* delivering a five-minute oral presentation on a topic based on media reports or current events linked with chemistry, supported by a minimum of three examples related to Area of Study 1.

Area of Study 2: What is the chemistry of food?

The inclusion of food chemistry is new content when compared to the previous study design, so it is not surprising that schools have chosen the familiar assessment task type of a ‘report on a laboratory investigation’, as shown in the graph below:

Many schools described undertaking an experiment formatively in one session, following it with the summative ‘report’ task the following session, drawing on students’ logbook records. Calorimetry was the most common context for the SAC task and provided schools with the opportunity to link back to Unit 3 Area of Study 1, as students calibrated their equipment with ethanol before burning a range of foodstuffs in order to validate manufacturers’ claims of energy content. Another common approach was to investigate enzyme action at varying temperatures and pH levels. Both approaches lend themselves well to modification over subsequent years, through variations in foodstuffs or the enzyme chosen for experimentation: for example, rennin, diastase, invertase, and pepsin.

Schools that used the ‘comparison of food molecules’ task generally structured the SAC task as a series of different questions that compared different pairs of molecules in a format similar to external examination questions. This task often led to ‘over-assessment’ of students, as commonly up to six comparisons were required to be made by students, with schools covering the entire range of food molecules specified in the study design. The task requires a comparison of only two molecules; schools may choose to compare two different molecules within one class of foods (carbohydrates, proteins, fats and oils, or vitamins) or a single molecule from each of two selected classes of foods. An example of an appropriate task was provided by a school that reported its students investigated the energy content and implications of low fat versus low sugar food items through the analysis of media articles to draw conclusions. Another approach is to set up a comparison table, specifying the criteria that will be used to compare the food molecules.

The ‘response to stimulus material’ task was incorrectly interpreted by schools as being a ‘test’ type task. This task lends itself particularly to selecting material related to a contemporary issue in food chemistry, with students being expected to discuss key chemical concepts and to provide a personal perspective related to any issues associated with the stimulus material as a measure of their scientific literacy. Schools are advised to refer to the [*VCE Chemistry Advice for teachers*](https://www.vcaa.vic.edu.au/curriculum/vce/vce-study-designs/chemistry/advice-for-teachers/Pages/Index.aspx) for further elaboration of this and other SAC tasks.

An appropriate SAC task related to the ‘reflective learning journal/blog’ task targeted the Paleo diet for evaluation through several media articles.

A significant audit issue for this SAC task was the inclusion by a number of schools of test-based items, generally drawn from previous VCAA examination papers, to supplement either the report of a practical activity or as part of other SAC tasks, resulting in the assessment tasks being invalid. Such items could be more appropriately used for formative assessment purposes.

Area of Study 3: Practical investigation

Specific dates for monitoring of stages should be provided to the students before the start of the task.

Most students chose an investigation methodology that was either a controlled experiment, a pattern seeking activity, or a single variable exploration. Very few schools reported students undertaking investigations related to classification, system development, or model exploration.

Some schools reported using electronic logbook records in order to track student editing. Most schools used hardcopy logbooks, while some structured a special logbook handout to help scaffold the task for the students, providing them with structural prompts. One school used both digital and hardcopy logs at different phases of the investigation.

Assessment of this outcome varied widely. The VCAA performance descriptors provided the framework for many schools. Marking guides drawn up by commercial providers were duly modified by many schools. Some schools used students’ logbook records for formative assessment only, while others had structured specific ‘checkpoints’ into the logbook completion that were considered alongside the poster itself in assessment. Some schools also included a post-poster oral assessment, having the students present their findings to an audience.

Audit concerns for Outcome 3 included:

* investigation titles that were not phrased as a question
* investigation questions that did not rely on practical experimentation to find an answer
* investigation questions that had obvious answers that could be predicted by using chemical relationships and equations, particularly Faraday’s Laws
* investigation questions that did not involve the generation of primary data
* students who were provided with a topic and possible variables, and therefore did not have an authentic opportunity to work independently to design their own investigations
* investigations that were either unsafe, too expensive or did not meet ethical guidelines
* investigation questions that could not be investigated in the allocated timeframe
* investigation questions that could simply be answered with ‘yes’ or ‘no’
* investigations that did not identify the variable being investigated and/or controlled
* investigations that were difficult to complete successfully
* lack of opportunity for students to investigate their own topics of interest
* too much time spent on researching background information related to topics outside the scope of the study design
* confusion between ‘affect’ and ‘effect’ in investigation titles
* schools that accepted submission of multiple drafts.

Schools may provide data to students in situations where, after designing and running their own investigation, students do not generate a viable set of data that can be analysed.