

Scientific Studies

2014 Chief Assessor’s Report

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## Overview

Chief Assessors’ reports give an overview of how students performed in their school and external assessments in relation to the learning requirements, assessment design criteria, and performance standards set out in the relevant subject outline. They provide information and advice regarding the assessment types, the application of the performance standards in school and external assessments, the quality of student performance, and any relevant statistical information.

## School Assessment

Assessment Type 1: Investigations Folio

The vast majority of classes had two practical investigations and one issues investigation in this assessment type and these were mostly at an appropriate Stage 2 standard. Many classes followed a theme and linked the tasks with the skills and applications assessment type, and the more successful classes were able to provide learning opportunities across a variety of topics, while ensuring competent assessment against the performance standards.

Folio tasks that allowed for ease of identification of student evidence of specific features within a performance standard led to a higher likelihood of grade confirmation at moderation. When a task indicates that specific features (such as design of an investigation, record and display information, work collaboratively, or analyse data) were to be assessed, opportunity needs to be provided for students to adequately complete the task at a level reflective of all grade bands. It is helpful if evidence of how the grade was achieved is provided.

Clear, informative task sheets that indicated the performance standards to be assessed, supported students to demonstrate evidence that was appropriate to the task. Tasks that encouraged students to explain and discuss rather than simply state information led to higher levels of achievement as students were able to demonstrate the analysis and evaluation criteria, as well as knowledge and understanding

Practical Investigations

It was evident that many teachers have adapted their practical investigations to allow students to address performance standards specific to practical design, reporting, discussion, and evaluation. Tasks that request students to answer questions that relate to the concepts often limited the ability of students to analyse the data or evaluate procedures. This led to reports that did not address the specific features of analysis and evaluation (AE1 and AE2).

Many students appeared to benefit from opportunities to complete formative practical tasks before submitting summative reports for assessment. Well prepared students were adept in using standard features of scientific reports, such as the presentation of tables with appropriate headings and units and correctly formatted graphs. In addition, terms such as ‘random and systematic errors’, ‘accuracy’, and ‘reliability’ were used appropriately and accurately. Students also benefitted from having opportunities to discuss trends in the data and to link their data to scientific concepts in their reports.

Students are required to design at least one practical investigation themselves. Teachers who included specific feature I1 (design of scientific investigations) supported students to provide evidence appropriate to investigation design. Feedback on the design is important, as it gives students the best chance of collecting adequate data that is worthy of discussion. A number of teachers have used checklists as evidence for specific features I3 (concerning the use of apparatus) and A3 (concerning work skills). Moderators can confirm grades for these specific features only on the basis of the evidence presented; therefore it is important to show how the grade was achieved.

Issues Investigations

Teachers are encouraged to help students with the selection of an appropriate issue that allows for critical evaluation of the relevant science related to the issue.

Investigations are best posed as a question to ensure that students adequately explore alternative points of view of an issue rather than provide information about a topic. Teachers are encouraged to set deadlines for drafts to ensure that adequate feedback can be given about citing and listing of sources, and to ensure that content is written in the students’ own words.

The information gathered from sources should be evaluated for bias, credibility, suitability, and accuracy. Some students find it helpful to have a pro forma to complete, but the more able students should be encouraged to present their evaluation in different formats that allow for more depth and less repetition. An example of an annotated bibliography is available on the SACE Scientific Studies minisite. Students should be encouraged to acknowledge their sources through adequate in-text referencing, as well as in a reference list.

Discussing specific feature I2, concerning critical selection from a range of sources, with students encourages them to ensure reliable peer-reviewed articles, government websites, or scientific journals make up the majority of selected sources, along with credible primary sources.

Assessment Type 2: Skills and Applications Tasks

Many of the successful classes carried a theme throughout the school-assessed components of the course including environmental science, human biology, the physical world, or human movement. Across the many classes, teachers used a wide variety of tasks in this assessment type and this is certainly encouraged.

Best-practice tasks provided opportunities for students to answer questions that requested students to list, describe, state, or recall; however, they also included questions of developing complexity (e.g. evaluate, explain, interpret, suggest), allowing students to demonstrate achievement at all levels of the performance standards. Effectively designed tests asked students to demonstrate their knowledge of science, but also provided ample opportunities for students to analyse and apply their knowledge. Tasks that included interpretation and analysis of unfamiliar diagrams or sets of data presented in different forms gave students opportunities to meet the highest levels of the performance standards.

Teachers are reminded to submit marked Skills and Applications Tasks for moderation. Many teachers also attached a copy of the performance standards to each task that clearly identified the student’s achievement level. This assisted in the moderation process, which seeks to confirm teachers’ original assessment

If a class is undertaking an oral presentation for this assessment type, teachers are encouraged to include a transcript or printed copies of PowerPoint presentations (4–6 slides per page) wherever possible. Evidence of specific feature A3 (Demonstration of skills in individual and collaborative work) was easy to identify when a checklist of individual and group skills, and a reflection of the group process was included as part of the evidence. In some instances, teachers included a USB drive containing a video of an oral presentation. Teachers should ensure that individual students and/or individual student files are clearly identified on USBs or DVDs. The SACE website contains information regarding the submission of electronic files.

Teachers are reminded that they do not need to assess each specific feature within every task. The more successful classes used a less-is-better approach. If the students are assessed on a particular specific feature, such as I2 (on critical selection from a range of sources), then all students must be assessed on this specific feature in that task. If teachers find that a specific feature they had intended to assess in a particular task does not fit the task, then they must include an addendum and explain why changes were made. Additionally, if changes are made to the teaching and learning program, teachers should go over their tasks to ensure all specific features are addressed and that the course still meets the requirements.

## External Assessment

Assessment Type 3: Practical Investigation

Despite the fact that the practical investigation forms 30% of the overall assessment, it is clear that not all students are provided with an opportunity to undertake or complete the practical component to the best of their ability. While the quality of reports continues to improve, the choice of investigation topic often limits students from potentially achieving in the A band. On some occasions, teachers narrowed the choices of investigation topics available to their students to a particular theme (e.g. vitamin C, fermentation, or catalase) for which a range of practical investigations were submitted. In other instances, students conducted the same practical but with a different independent variable, perhaps influenced by what happened in previous tasks. This practice should be discouraged in Scientific Studies, as it is very hard to assess a proposal when the whole class has the same method except for the independent variable.

A further concern is that simulation practicals were noted among the practical investigations. Simulation practicals do not fit within the concept of practical investigations, as described in the subject outline for Scientific Studies, because simulations deliver pre-determined values derived through the use of a computer program.

It was also disappointing to see some investigations where an independent variable had been identified but no variable had actually been altered within the investigation, or where no independent variable was listed and therefore no hypothesis was proposed. These situations should have been rectified at the proposal stage where the teacher provides feedback and works with students to redesign the practical.

On ethical and safety grounds, investigations involving potentially excessive consumption of caffeine in its various forms should also be actively discouraged.

It was apparent that the time available for doing experimental work and writing it up varied dramatically, ranging from one lesson to do the experiment and about 2–3 weeks to write it up, to several lessons over a couple of weeks and 1–2 months to hand in the final piece of work. This variation significantly affected the overall quality of the report; for example, the shorter timeline limited opportunities for replicates to be collected so that averages could be generated and sources of errors adequately discussed. It would seem that very short timelines are inadequate for the external component worth 30% of the final grade for Scientific Studies. However, teachers should avoid excessively long timelines, as these may encourage students to devote too much time to the investigation, not commensurate with the marks available.

The use of headings and subheadings within the report is highly encouraged, as their use will greatly assist students to structure their responses appropriately.

Given that the report is worth 30% of the assessment, it is disappointing that students did not make full use of the word-count available for the report to ensure a comprehensive analysis and evaluation section was completed. As a general rule, the students who achieved well in this task allocated approximately 500 words to the rewrite of their proposal and 1500 words to the results, analysis and evaluation, and conclusion.

In summary, teachers have the responsibility to ensure that all investigations undertaken within their classes are of an appropriate standard and quality for this Stage 2 Science subject. They must also allow students to safely and ethically conduct experiments over a wider range of topics and ensure that students are provided with every opportunity to achieve an A for this assessment task.

Care must be taken to ensure that neither the school name, school SACE number, nor the student’s name appears anywhere within the report. Teachers are reminded; once again, that teacher marks must not appear on or attached to students’ reports submitted for external assessment.

The following material concerns specific comments on the design proposal and the sections of the report.

Proposal

Some teachers provided a pro forma for students to complete for their design proposal. It was noted that this practice significantly restricted the quality of the designs and that, if the students had instead been just given headings as a guide, the better students would have had an opportunity to display their depth of knowledge and understanding. If pro formas are supplied, teachers should ensure that the space allocated does not limit the students.

Concern was expressed in situations where the submitted proposals were identical to the final version of the method within the report. It was not clear whether the proposal was the original version or the edited version, or perhaps even a version prepared after the final report was completed.

Further, some proposals were devoid of teacher feedback, while other practical investigations lacked a proposal. In the latter situation, it is unclear whether proposals were ever prepared, as some reports contained crucial design errors that would have been corrected if an original proposal had been submitted.

It was noted in a significant number of proposals that some methods had been clearly researched from the Internet. While some research may assist students in their design, teachers are reminded that the proposal is being assessed on the student’s own design of an investigation and that teachers verify that it is the student’s own work.

Introduction

While an introduction is useful, care must be taken to ensure that it is succinct and relevant and referred to during the analysis of the data. There is no requirement for a student to provide an abstract in the report. With both the abstract and the introduction, valuable words can be wasted that are better used elsewhere within the report, such as in the analysis and evaluation section.

Writing a hypothesis is difficult for some students. Evidence was noted of poorly worded hypotheses that (a) failed to link an independent variable with a dependent variable, (b) provided two independent variables, or (c) linked one independent variable with two dependent variables.

It was also noted that some hypotheses were too simple, for example, temperature versus dissolving, suggesting that the quality of the investigation was inadequate.

Method

The method component, for the most part, was well prepared, with many students detailing the materials needed and listing the procedural steps employed. However, using paragraphs in this section rather than listing procedural steps is not the preferred way of outlining the method. Also, a frequent fault observed was that one or two crucial instructions were often found to be missing, which would make the investigation difficult if it was to be repeated by someone else.

The need for an adequate sample size in a range of investigations remains inadequately addressed and clearly this aspect warrants considered attention in the future.

Finally, some classes conducted the experiments in pairs or groups, modifying a class practical which had been done earlier as a trial. This resulted in the sharing of results, which is acceptable, and much similar information in the students’ introductions and diagrams in their method, which is more problematic. The similarity made it difficult for the markers to discriminate between what was provided by the teacher and what was the work of the individual student.

Results

Copious tables and graphs were noted in some reports that would have been better displayed as summary tables and, where warranted, by combined graphs. Where multiple data is supplied, the use of averaged results is recommended. However, students must remember that any average listed must contain the correct number of significant figures as determined from within the original data. Students are reminded to consider what is the appropriate graph format for their data, which will be determined by the nature of their investigation. If the data is continuous data (such as a range of concentrations, times, or pHs) then the data must be plotted as a line graph (showing the points with a line of best fit), whereas non-continuous data (different age groups, or genders) must be plotted as a histogram. Graphs have often been drawn with programs such as Excel, where the X-axis has been drawn incorrectly and this arises from choosing the wrong format for line or scatter plots. Where multiple graphs are used, students must ensure that the same scale is used on the Y-axis in each graph. Using commercial programs to prepare graphs unfortunately does not ensure that the same scale on the Y-axis is always displayed. As a consequence, the shape of a graph can become quite distorted, which can perhaps mislead a student to propose an incorrect interpretation.

A number of reports are still being submitted as black and white copies, whereas the original graphs and diagrams were in colour. As the interpretation of graphs often relies upon on being able to differentiate coloured lines, this sometimes cannot be discerned in grayscale.

Some investigations included qualitative results only. For example, some experiments involving micro-organisms were just ‘qualitatively’ analysed by photographs, whereas the zones of inhibition of bacterial growth, or the height/volume of foam produced by fermenting yeast, can actually be measured to provide quantitative results, thus enabling much better analysis.

In a number of investigations involving micro-organisms, the ability of students to identify specific bacterial species on the basis of colour and colony morphology must be questioned. Such an assessment is extremely unreliable, as the only real way to identify such micro-organisms is through conducting various biochemical tests. It is highly unlikely that schools have the appropriate facilities for such tests.

Analysis and Evaluation

The analysis and evaluation components of the reports for a number of students were very heavily scaffolded, as the layout and phrases, and often sentences, were commonly identical across the class. While some form of scaffolding is appropriate, elaborate and detailed scaffolding rarely allows students the opportunity to analyse and evaluate their data in a ‘highly effective manner’. In numerous cases, detailed analysis of data, instead of providing little more than a regurgitation of raw data, may have generated a different outcome for students to consider. In some cases, detailed analysis may have actually confirmed their hypotheses rather than refuting them. For example, students may have completed an experiment with replicates, but then not bothered to generate an average.

Responses sighted in the analysis of students’ data highlighted that many students were not fluent with the concept of outliers, where they may exist within their data, and what the implication of outliers may have on the analysis of their data.

A consistent problem in this section was the lack of understanding of random and systematic errors. In conjunction with the discussion of random and systematic errors, the incorrect use of the terms ‘accuracy’, ‘precision’, ‘scatter’, and ‘reliability’ was often evident.

All practical investigations require a suitable sample size to help verify results obtained within the investigation (thus reducing the effect of random errors through averaging results), as well as the opportunity for the investigation to be repeated, which takes into account whether systematic errors were present or not. While students may not have the opportunity to repeat their investigation, they should be able to address the sample size issue within the investigation. It was noted that many students performed their investigation once only, while others had relatively small sample sizes — in both cases, the final sample size was minimal at best.

Discussing possible improvements for the investigation was noted in most reports. However, many students do not seem to be fully aware of what ‘appropriate improvements’ means, let alone be able to discuss why. Often, a listing of possible improvements is all that was provided and greater effort needed to be applied. As alluded to earlier, the choice of investigation topic can severely hamper students as quality improvements for their specific investigation were not always possible given the simplistic nature of their experiment.

Given that specific feature AE1 (concerning analysis of data) has equal value to other performance standards, it is essential that students demonstrate their ability to find patterns in their data and link data with scientific concepts. Overall, not enough evaluation of results was evident in many reports; however, students who performed well were able to link the background science to their results.

It is suspected that some teachers were not marking to the correct specific features for the investigations, as many reports spent a significant number of words highlighting ‘safe and ethical’ practices and risk assessments, when this may only be a minor component of the investigation. It is recommended that teachers review the assessment requirements for the practical investigation and, where necessary, make the adjustments so that their students receive the marks that they rightly deserve.

Conclusion

Students are reminded to ensure that they use a conclusion section in their report to address the specific feature AE1 which refers to formulating a conclusion. Students should discuss whether the data they collected supports or refutes the hypothesis.

## Operational Advice

School assessment tasks are set and marked by teachers. Teachers’ assessment decisions are reviewed by moderators. Teacher grades/marks should be evident on all student school assessment work.

Variations — Moderation Materials forms were not always submitted when tasks were missing; this made it difficult to determine how a student’s final grade had been derived. The form should clearly identify the reasons for missing or incomplete work.

Grades allocated should reflect the work submitted to and marked by the teacher and/or granting of special provisions or reductions in the overall grade due to non-submitted work.

When student materials are packaged for moderation, it is useful for an overall summary of assessment decisions for all tasks, indicating the performance standards used, to be included.

Teachers’ marks and comments must not appear on either the proposal or the report submitted for external marking. Neither the school name or SACE number, nor the student’s name, must appear anywhere in the report. Students should be identified only by their SACE registration number.

## General Comments

Teachers are encouraged to attend a clarifying forum to become more familiar with performance standards and task design and to use information provided on the Scientific Studies minisite.

Teachers are encouraged to provide sufficient opportunity for critical analysis in their task design, and to examine their tasks to ensure students are asked to use higher-order thinking skills in summative tasks.

Teachers are reminded to ensure that they retain copies of student work throughout the year so that the work is available as evidence for moderation at the end of the year.

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