LEVEL 3 EXTENDED CERTIFICATE

APPLIED SCIENCE

ASC5: Investigating Science
Report on the Examination

1777
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General

January 2019 was the second time when submissions for ASC5 had been made. As with all coursework units, this is a 60 guided learning hour's unit and should also reflect the Level 3 nature of the award.

The unit is assessed via a number of Performance Outcome (PO) criteria which are a combination of research, scientific principles, various aspects of investigative procedure, practical work, analysis and evaluation of data, and reporting outcomes. Links to commercial and/or industrial processes are also part of the assessment procedure.

The investigations followed in the submissions seen included several of those suggested in the specification including:

- immobilised cells
- fermentation
- wind turbines
- reaction time.

These were completed with varying degrees of success and at different levels of sophistication. Most (but not all) students were able to achieve credit for following the basic aspects of investigative procedure at Pass criteria levels. However, accessing most Merit and Distinction criteria at the levels of depth and breadth expected was found to be difficult by some, although this was, to an extent, a college specific issue.

There were some excellent examples of investigations, characterised by:

- comprehensive portfolios created with a firm understanding of the depth of treatment expected
- excellent research and use of secondary sources leading to...
- …good levels of scientific knowledge and understanding consistent with Level 3 standards
- wide ranging approaches to the investigation reflecting a suitable choice of factors to investigate
- appropriate practical methods for a Level 3 investigation producing accurate and reliable data
- high level analysis, manipulation and evaluation of data
- sensible marking by assessors who clearly understood the need for content at an appropriate level
- clear college annotation identifying where performance outcomes had been met and awarded.

Whilst most of the investigations submitted may have had the potential to allow access to the criteria, some were limited by the narrowness of approach and a general lack of understanding of the standards expected.

In general, these were typified by:

- limited research into the scientific background
- few variables / 'factors' considered or investigated (sometimes only one)
- only one standard procedure identified, used or trialled (and sometimes issued, not researched)
- restricted outcomes and levels of data recorded
- limited practical work
- low level apparatus and practical approaches
- little or no college annotation to support award of marks.

Students would benefit from guidance on the following:

- the levels of science expected and the depth of knowledge and understanding that should be demonstrated
- using practical techniques of suitable levels of demand and avoiding simple GCSE level work
- how to access sources which are not predominantly based on GCSE work (or below).

With the right decisions, many investigations can meet all the criteria at a good level. However, it is possible for two investigations with the same title to be met by one at Distinction level and another at below Pass level depending on the decisions made and approaches adopted.

To an extent, some credit may be available if investigative processes and procedures have been followed. But many criteria will not be met using low level approaches and practical work, limited application of scientific principles, and restricted, inaccurate or unreliable data.

P01: Prepare for a scientific investigation

P1, M1, D1

These criteria involve progressively more research and more detailed explanations of scientific principles across the performance outcomes grid. The principles to be covered concern all aspects of the investigation including:

- the scientific area concerned and the underlying theories and principles
- the science related to the relevant procedures, techniques and possible approaches
- the science relating to the variables / factors to be investigated
- the science related to all other factors / variables which may be relevant and have to be controlled during experiments.

Some investigations will have direct, extensive links to other areas of the specification, for instance 'reaction time' and ASC4, and this gives an idea of the level of theory that is appropriate. In this example, relevant parts of 'the structure and function of the nervous system and brain' and 'nerve impulses' from ASC4 would provide a good high level basis for the scientific principles behind the investigation. Other investigations should try to mirror these levels of approach.

Often, if the levels of science are appropriate at this stage, much of the rest of the investigation falls more easily into place. If the science is too narrow and / or low level, it is likely that so will be the rest of the investigation.

For example:

- reaction time, but without identifying and discussing the necessity to control the many variables that apply: age, gender, practice, caffeine, fatigue, etc.
- fermentation in the brewing industry without planning to use the correct yeast strains and following experiments through to conclusions with appropriate commercial links
- wind turbines but without considering the need to research all the relevant factors or the need to source suitable practical equipment to generate acceptable results.

P2, M2, D2

These criteria are also connected and move on sequentially from Pass to Merit to Distinction. **P2** requires a plan to be produced, although it was often just implied rather than being clearly identifiable in portfolios. The plan should incorporate:

- **researched** standard procedures/techniques to be followed
- potential alternative methods/techniques/procedures for comparison in trials
- aims / purposes of the tasks (objectives).

Trials of potential standard procedures are carried out and details of these and their results are required for **M2**. Trials are designed to identify the standard procedures to be used in the main investigation, and how variables are best controlled to give accurate, reliable data. Changes to the plan, including modifications of parameters need to be described for M2, and the final chosen techniques justified for **D2**.

In lower-scoring portfolios, trials were usually limited as they were not aimed at trialling methodology, and subsequent modifications were not extensive, if present at all.

PO2: Carry out the investigation and record results

P3, M3

Over the whole entry risk assessments were not done well. This is surprising as these students will have previously submitted ASC2 and the college will be aware of the Reports on the Examination for previous series and also their own Feedback Report.

P4

This is awarded for following the standard procedures (Observation Record required) and also for using 'a range of practical equipment and materials'. Several lower-scoring investigations were seen where the 'range of equipment and materials' was not met due to the restricted nature, simplicity and very low level of the practical work.

The portfolio evidence needs to include copies of all standard procedures and the results, correctly tabulated. The standard procedure should be suitably detailed to allow it to be followed to a successful conclusion and replicate results.

P5, M4, D3

For **P5**, data must be recorded to correct levels of precision (significant figures/decimal places) with correct units and adhering to normal conventions. The following points are also important:

- It is assumed that all data recorded are the student's own (students and assessors sign the Unit Submission form to confirm this).
- If any secondary data, including data from other students or group work, are included, these should be tabulated separately and annotated accordingly.

M4 assesses effectiveness of methods used from the perspective of the recorded quantitative data, and also considering the method and apparatus used:

- Are data complete / are sufficient data recorded?
- Are sample sizes adequate?
- Is the precision of recording appropriate?
- Are there any anomalies?
- Are the data repeatable / reliable?
- Are there any issues with accuracy?

D3 then considers the responses made in M4 and makes suggestions for improvements that would lead to more accuracy, reliability, etc. These improvements could be to the methodology employed and / or to the equipment used.

P03: Analyse results, draw conclusions and evaluation the investigation

P6, M5, D4

P6 would include suitable calculations and analysis of data using graphs and charts.

M5 requires data to have been manipulated and that the methods, including IT, are appropriate suitable uses of IT could include graphical analysis, generation of charts, use of (non-trivial) spreadsheet formulae.

The use of IT does have to be appropriate, and should enhance the ways in which data are manipulated and presented and allow conclusions to be drawn later (P8). Students should be aware that some Excel graphs are too simplistic, often with inappropriate lines of best fit.

D4 discusses the methods and formats used in the analysis in the context of the outcomes and their relevance to the original aims of the investigation. Justifications can also consider the methods used and what further information or outcomes are derived as a result of using those methods.

P7, M6

P7 identifies sources of error and anomalous data. Errors may be qualitative, based on the methodology used, and quantitative, being related to the measurements made and the levels of precision of recording.

M6 then explains these sources of error and ways of minimising them, for instance in terms of the instruments used, number of repeats, minimising importance of anomalies.

P8, M7, D5

Conclusions, which were often an aspect of portfolio content that students find difficult, should be clearly linked to the objectives established at the planning stage, and related to the data obtained. For **M7**, conclusions should then be compared with equivalent information (values, data) gained from secondary sources: for example researched expected outcomes.

There was often little or no evidence of any comparison of conclusions drawn on primary data and those based on secondary data. **P8** and **M7** were particularly tough areas for most students. Using other students' results as secondary data may well be of limited value, and should not be seen as a substitute for extensive research and recording of relevant secondary data from reliable sources.

D5 ties together the explanations in M6 and the review of outcomes in M7. A full evaluation of the outcomes and qualitative and quantitative errors is an essential start point. The use of percentage errors can then lead to a comparison of the accuracy of the calculated outcomes with expected values in the context of the overall error.

PO4: Present the findings of the investigation to a suitable audience

P9, M8, D6

The report on the investigation is effectively the portfolio and no separate 'mini-report' is expected. The presentation can be in various formats, but should be designed for a suitable audience, and should be appropriate for that audience. The presentation should contain text and images.

However, care should be taken with Powerpoint presentations as some were seen with slides that are far too verbose. **P9** does use the word 'concise': many students would benefit from guidance in the design and content of Powerpoint presentations.

On the other hand, leaflet based presentations were used well for some investigations and audiences

M8 connects to M7 in terms of secondary data, but does cover its use in other POs such as P1, M1, and D1. M8 also has the additional expectation of use of correct scientific terminology throughout the report and presentation.

D1 related the researched science to industrial/commercial uses. D6 revisits these, but from the point of view of the relevance of the results and outcomes of the investigation to those industrial processes.

P10, M9

P10 is quite simple to achieve, assuming sources have been used in research for PO1 and for secondary data for M7 and D6.

Only a simplified version of the Harvard Referencing Style need be used, such as a numbered reference (eg [12]) in the body of the text, and the reference listed in a footer or in a bibliography at the end.

M9 requires 'usefulness' (often missed out in many portfolios) and 'validation' (also often missing or misunderstood by colleges and students) – both are expected for M9 to gain credit.

Validation can consider a whole range of checks and ideas depending on the nature of the source. Approaches may include reference to the following as appropriate:

- type of publication, who published it and where
- purpose of the publication
- academic standing of the author
- advertising / Government / academic / commercial / industrial/ pressure group …..
- peer review / editorial control / adopted textbook / book reviews / citations / cross referencing.

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