| Design | | Complete / 2 | Partial / 1 | Not at all / 0 |
|---|---|---|---|---|
| ASPECT | Define problem & select variables | Formulates a **focused problem/ research question** and identifies the relevant variables. | Formulates a problem/research question that is incomplete or identifies only some relevant variables. | Does not identify a problem/ research question AND does not identify any relevant variables. |
| | Controlling variables | Designs a method for the **effective control** of the variables. | Designs a method that makes some attempt to control the variables. | Designs a method that does not control the variables. |
| | Developing a method for collection of data | Develops a method that allows for the collection of **sufficient relevant data.** | Develops a method that allows for the collection of insufficient relevant data. | Develops a method that does not allow for any relevant data to be collected. |

**Design**

**Aspect 1: Define the problem and select the variables**

- ☐ Research Question or Aim clearly stated
- ☐ RQ/Aim includes IV and DV
- ☐ Background to investigation included
- ☐ IV correctly identified with units/ range
- ☐ DV correctly identified with units and precision

*If a hypothesis is required:*

- ☐ It is quantitative / written appropriately
- ☐ Null hypothesis- if stats require it
- ☐ Prediction is explained using scientific theory
- ☐ Sources are cited

**Aspect 2: Controlling variables**

- ☐ Method to manipulate IV, including specific details of range or increments
- ☐ Method for recording results, including units and uncertainty of tools (± _____)
- ☐ Annotated photo of equipment or experimental set-up
- ☐ **Full citation** of published protocol, if used

*Controlled variables presented as a table:*

- ☐ **List all variables** to be controlled

***For each variable:***

- ☐ How could it impact the results?
- ☐ Exactly how will it be controlled?

**Aspect 3: Developing a method for collection of sufficient relevant data**

- ☐ Results table designed before investigation was planned, to guide Design
- ☐ How will results be presented? Reason.
- ☐ What statistical test(s) will be used? Why?
- ☐ Does plan to collect data address RQ?
- ☐ **Min. 5 increments** over a suitable range for the IV (unless comparing populations)
- ☐ **Explain** how range of IV was selected
- ☐ **Explain** how raw data will be transformed into processed data for comparison/ plotting
- ☐ Sufficient repeats (trials) at each increment to ensure reliability and allow for stats.
- ☐ Method clearly presented in step-wise format and can be repeated by others.
- ☐ **Safety/ ethics concerns addressed,**

Conclusion and Evaluation

| ASPECT | Complete / 2 | Partial / 1 | Not at all / 0 |
|---|---|---|---|
| Concluding | States a conclusion **with justification**, based on reasonable interpretation of the data. | States a conclusion based on a reasonable interpretation of the data. | States no conclusion OR the conclusion is based on an unreasonable interpretation of the data. |
| Evaluating procedures | Evaluates weaknesses and limitations. | Identifies some weaknesses and limitations, but the evaluation is weak or missing. | Identifies irrelevant weaknesses and limitations. |
| Improving the investigation | Suggests realistic improvements in respect of identified weaknesses and limitations. | Suggests only superficial improvements. | Suggests unrealistic improvements. |

**Conclusion and Evaluation**

**Aspect 1: Concluding**

- ☐ Patterns and trends in data stated, with reference to the graph/ tables.
- ☐ Comparisons, if appropriate, are made
- ☐ Data related to hypothesis or RQ – to what extent to they agree/ disagree?
- ☐ **Scientific explanation** for results
- ☐ Comparison with published data and theoretical texts, if possible.
- ☐ Appropriate language used *"Supports my hypothesis"* (not 'proves' or 'is correct')
- ☐ Associated qualitative data add value to explanations.
- ☐ Sources cited appropriately
- ☐ Suggestions for further investigation stated

**Aspect 2: Evaluating procedures**

- ☐ Reference to error bars (or STDEV) with regard to variability of results
- ☐ **Analysis** of reliability of results:
- ☐ Are data sufficient to address the RQ?
- ☐ Was the range of the IV appropriate?
- ☐ Identify & Explain anomalous data points
- ☐ Refer to quantitative data

Evaluate *random biological variation, measurement/ instrument errors, systematic error* (problems with the method) in terms of:

- ☐ Possible effect on data
- ☐ Significance of the weakness or limitation in terms of the data set

*This can be clearly presented in a table.*

*Time management* or *human error* may be mentioned, though these are not scientific errors – they should be eliminated with good practical skills. The focus here should be on *the investigation.*

**Aspect 3: Improving the investigation**

For each weakness or limitation mentioned above, how could improved experimental design remove or reduce the impact of the error in terms of:

- ☐ Techniques used to collect and record data, including precision of equipment
- ☐ Design of the investigation, including range of values chosen and repeats of each IV data point
- ☐ Realistic, specific and achievable improvements

*Adapted from Stephen Taylor's work from BIS (Bandung International School)

## Data Collection and Processing

| ASPECT | | Complete / 2 | Partial / 1 | Not at all / 0 |
|---|---|---|---|---|
| | Recording raw data | Records appropriate **quantitative data and associated qualitative raw data**, including units and uncertainties where relevant. | Records appropriate **quantitative and associated qualitative raw data**, but with some mistakes or omissions. | Does not record any appropriate quantitative raw data OR raw data is incomprehensible. |
| | Processing raw data | Processes the quantitative raw data correctly. | Processes quantitative raw data, but with some mistakes and/ or omissions. | No processing of raw data is carried out OR major mistakes are made in processing. |
| | Presenting processed data | Presents processed data appropriately and, where relevant, includes errors and uncertainties. | Presents processed data appropriately, but with some mistakes and/or omissions. | Presents processed data inappropriately **OR** incomprehensibly. |

**Data Collection and Processing**

**Aspect 1: Recording Raw Data**

- ☐ Raw data clearly distinguished from processed data (possibly separate table)
- ☐ Units of IV and DV present and correct
- ☐ Uncertainties correct (± __ )
- ☐ All data are recorded correctly and honestly
- ☐ Decimal points consistent throughout
- ☐ Decimal points consistent with precision of the measuring equipment
- ☐ **Associated qualitative data** (observations) MUST be recorded or zero awarded.

**Aspect 2: Processing Raw Data**

- ☐ Calculations to determine DV carried out, if necessary
- ☐ Calculations or statistical tests appropriate to investigation and address RQ
- ☐ Mathematics correctly applied
- ☐ Worked example calculations given
- ☐ Standard deviations included where appropriate, with appropriate DP.
- ☐ Uncertainties adjusted to reflect any calculations carried out.
- ☐ Processed data (and decimal places) consistent with precision of recorded data

**Aspect 3: Presenting Processed Data**

- ☐ Tables & graphs do not break across pages
- ☐ Titles self-explanatory and complete
- ☐ Consistent decimal places
- ☐ Uncertainties/ errors included
- ☐ Appropriate choice of graph
- ☐ Graphs clear, coloring appropriate
- ☐ Effective use of space
- ☐ Axes labeled clearly, including metric/ SI units and uncertainties of values
- ☐ Axes scaled appropriately
- ☐ Error bars included, unless insignificant
- ☐ Error bar source (e.g. standard deviation) stated and s.d. data are correct
- ☐ Best fit line produced by you, not Excel.