

Design

Title:

Name:

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

Aspect 1: Define the problem and select the variables

- | | |
|---|--|
| <ul style="list-style-type: none"> <input type="checkbox"/> Formulates a focused problem or research question (RQ) including IV & DV. <input type="checkbox"/> Independent (changed) Variable (IV) identified including range of measurement (s) e.g. 5cm, 10cm, 15cm. <input type="checkbox"/> Identify dependent Variable (DV) and includes units of measurement (must be quantitative) e.g. cm, kg, sec, bpm. <input type="checkbox"/> A list of all the key controlled and confounding variables, which may affect the DV. | <p style="text-align: center;"><u>Encouraged</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Error margin included in DV e.g. cm (+- 0.5cm), kg (+-0.5kg), sec (+-0.5sec) <input type="checkbox"/> Explain degree of error and classify it as mechanical or human error. <input type="checkbox"/> A hypothesis is given <u>linking</u> the IV with the DV. <input type="checkbox"/> Scientific background is referenced (and supports the hypotheses) |
|---|--|

Aspect 2: Controlling variables

- | | |
|---|--|
| <ul style="list-style-type: none"> <input type="checkbox"/> The method is detailed, numbered and can be followed with no previous knowledge (eg protocol, equipment, sample, numerical amounts, units of measurement). <input type="checkbox"/> Reference made to controlled table if all points are not referred to in the method. <input type="checkbox"/> It is clear <u>how</u> the IV will be changed and kept constant (only IV is changed). <input type="checkbox"/> It is clear <u>how</u> the data (DV) will be measured/collected along with a discussion on the error of equipment e.g. cm (+-0.5cm). <input type="checkbox"/> It is clear <u>how all</u> the variables will be controlled/kept constant and how they may affect the DV using numbers (same temperature i.e. 25°C) – links to validity/reliability. | <ul style="list-style-type: none"> <input type="checkbox"/> Test, standard measurement or sources are referenced. i.e. bleep test, vertical jump if used as part of IA. <input type="checkbox"/> Subjects/equipment are given time to equilibrate in new conditions before measuring eg. subjects are given recovery time to allow their performances to not impact on each other via fatigue – the heart rate of subjects is used. <p style="text-align: center;"><u>Encouraged</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Diagram/photo is given to help show how variables are kept constant. <input type="checkbox"/> Identifies relevant qualitative data – must link to DV. <input type="checkbox"/> Use scientific knowledge to explain how each variable can affect the DV. <input type="checkbox"/> State relevant confounding variables |
|---|--|

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

- | | |
|---|---|
| <ul style="list-style-type: none"> <input type="checkbox"/> Apparatus/materials are identified. <input type="checkbox"/> 5+ students for each condition to allow statistical analysis. <input type="checkbox"/> 3-5 treatments (ensure reliability/ allow for stats) for IV if manipulating variables/cause-effect i.e. 15°C, 20°C, 25°C, 30°C (Correlation measures degree of relationship and IV is not manipulated). | <ul style="list-style-type: none"> <input type="checkbox"/> 3-5 trials for each variable. <p style="text-align: center;"><u>Encouraged</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Error margin included in equipment list i.e. bpm (+-6 bpm). |
|---|---|

Comments to support teacher marks:

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

Aspect 1: Recording Raw Data

- Data is **raw** i.e. what has been measured and not averages.
 - Tables have full descriptive titles containing both the dependent and independent variables.
 - Must have units** in IV and DV present and correct.
 - Tables have headings and units (in column heading).
 - Degree of precision is correct i.e 0.5cm.
 - All the data has the same number of decimal places/significant figures and these match the uncertainties.
 - If class data is pooled students own data is identified in the table.
 - Relevant qualitative data is stated i.e. specific anomalies observed / athletes behavior, mood, prior injuries, food intake, audience effect
- Encouraged**
- Pooled class data: own raw data presented in first table, followed by pooled class data in a second table (own data must be highlighted).
 - Explain (underneath table) degree of error and classify it as mechanical or human error.

Aspect 2: Processing Raw Data

- Raw data is averaged and attached to raw data table or presented separately in a concise format.
- Tables have full descriptive titles containing both the dependent and independent variables.
- Tables have headings and units (in column heading).
- All the data has the same number of decimal places/significant figures as raw data.
- If class data is pooled students own data is identified in the table.
- Suitable processing has been carried out e.g.
 - Mean
 - Standard Deviation
 - % differences
 - R² value
 - Statistical test e.g. t-test
- Worked examples (ideally 2-3) of all calculations
- Processing (calculations) are correct.
- Obvious anomalies are highlighted along with a justification if they are excluded from calculations.

Aspect 3: Presenting Processed Data

- Correct graphs have been selected for processed data ie scatter plots, bar charts, line graphs.
 - Processed data (averages) and not raw data is plotted on graph.
 - Graph has a fully descriptive title to match data tables.
 - Suitable scales are used for the axes.
 - Axes have labels & units.
 - Independent variable is on (x) axis and dependent data is on (y) axis (in general)
 - Error bars if used are accompanied by an explanation of what the values mean.
 - Legend/key included if relevant.
 - Scatter graphs plotted with 'x' only have a line of best fit if there is a correlation, if there is no relationship no correlation is required.
- Encouraged**
- Description of relationship written under each graph.
 - Error margin added on axis with relevant unit of data.

Comments to support teacher marks:

C & E

Title:

Name:

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

Aspect 1: Concluding

Discuss

- Discuss trends in processed data/graphs using numbers.
- Reference to appropriate statistical test/standard deviation using numbers.
- Reference to qualitative data (observations) to explain trends or anomalies (if relevant).

Explain

- Explanation of the 'science' to explain results (references are given for research on background material).

Compare

- Compare own results with literature values or other researchers in text books/journals (referenced).

Encouraged

- Hypothesis rejected/accepted.
- Discussion on whether the research is **valid** and the measurement **reliable**.
- Major weaknesses (aspect 2) are supported through discussion of trends/anomalies

Aspect 2: Evaluating procedures

Weakness

- Student goes beyond stating ran out of time, test more subjects, perform more trials and use more precise equipment.
- Description of at least 3 major weaknesses (in addition to the above) and more if there were more within the method.

Significance

- Significance of weakness is discussed i.e. high to low and how they may impact the reliability/validity of IA.
- Weaknesses of 'high' significance are supported by data in discussions through the CE (if the weakness had no effect on data it is not significant).

Aspect 3: Improving the investigation

- Realistic improvements are given to support each limitation identified.
- Suggested modifications/improvements are specific and detailed i.e. improvements include numbers, use of precise equipment or techniques.
- References are given where relevant (to publish protocols or techniques).

Students to represent CE Aspect 2 & 3 as a table (3 columns) with the following headings:

- **Identified weakness** (starting with the most influential based on data gathered).
- **Significance of weakness** (impact from high to low based on data gathered – there must be evidence to support major weaknesses).
- **Suggested improvement.**

Comments to support teacher marks: