**Investigation 11: Simulation tomato leaf lab**

To view the various elements of this example, please use the icons at the side of the screen.

**Note:** The comments in the annotated examples match the labelling on teacher forms.

**Investigation 11: Moderator comments**

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| **Personal engagement**  **x/2** | **Exploration**  **x/6** | **Analysis**  **x/6** | **Evaluation**  **x/6** | **Communication**  **x/4** | **Total**  **x/24** |
| 2 | 4 | 3 | 2 | 3 | 14 |

**Personal engagement**

This criterion assesses the extent to which the student engages with the exploration and makes it their own. Personal engagement may be recognized in different attributes and skills. These could include addressing personal interests or showing evidence of independent thinking, creativity or initiative in the designing, implementation or presentation of the investigation.

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| **Mark** | **Descriptor** |
| 0 | The student’s report does not reach a standard described by the descriptors below. |
| 1 | * **The evidence of personal engagement with the exploration is limited with little independent thinking, initiative or creativity.** * The justification given for choosing the research question and/or the topic under investigation does not demonstrate **personal significance, interest or curiosity.** * There is little evidence of **personal input and initiative** in the designing, implementation or presentation of the investigation. |
| 2 | * **The evidence of personal engagement with the exploration is clear with significant independent thinking, initiative or creativity.** * The justification given for choosing the research question and/or the topic under investigation demonstrates **personal significance, interest or curiosity.** * There is evidence of **personal input and initiative** in the designing, implementation or presentation of the investigation. |
| **Moderator’s award**  2 | **Moderator’s comment**  There is evidence of the candidate developing a purpose for the investigation set in a real-world context. However, the amount of personal input requires development. |

**Exploration**

This criterion assesses the extent to which the student establishes the scientific context for the work, states a clear and focused research question and uses concepts and techniques appropriate to the Diploma Programme level. Where appropriate, this criterion also assesses awareness of safety, environmental, and ethical considerations.

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| **Mark** | **Descriptor** |
| 0 | The student’s report does not reach a standard described by the descriptors below. |
| 1–2 | * The topic of the investigation is identified and a research question of some relevance is **stated but it is not focused**. * The background information provided for the investigation is **superficial** or of limited relevance and does not aid the understanding of the context of the investigation. * The methodology of the investigation is only appropriate to address the research question to a very limited extent since it takes into consideration few of the significant factors that may influence the relevance, reliability and sufficiency of the collected data. * The report shows evidence of limited awareness of the significant **safety**, ethical or environmental issues that are **relevant to the methodology of the investigation**\*. |
| 3–4 | * The topic of the investigation is identified and a relevant but not fully focused research question is described. * The background information provided for the investigation is mainly appropriate and relevant and aids the understanding of the context of the investigation. * The methodology of the investigation is mainly appropriate to address the research question but has limitations since it takes into consideration only some of the significant factors that may influence the relevance, reliability and sufficiency of the collected data. * The report shows evidence of some awareness of the significant **safety**, ethical or environmental issues that are **relevant to the methodology of the investigation**\*. |
| 5–6 | * The topic of the investigation is identified and a relevant and fully focused research question is clearly described. * The background information provided for the investigation is entirely appropriate and relevant and enhances the understanding of the context of the investigation. * The methodology of the investigation is highly appropriate to address the research question because it takes into consideration all, or nearly all, of the significant factors that may influence the relevance, reliability and sufficiency of the collected data. * The report shows evidence of full awareness of the significant **safety**, ethical or environmental issues that are **relevant to the methodology of the investigation**\*. |
| **Moderator’s award**  4 | **Moderator’s comment**  The topic is identified and the research question is reasonably focused. Some relevant background information is provided but the relevance of C3 plant physiology needs clarifying.  It is not clear from the method what is being measured in the simulations. Why is leaf area measured?  The safety, ethical and environmental impact issues are not relevant here. |

\* This indicator should only be applied when appropriate to the investigation.

**Analysis**

This criterion assesses the extent to which the student’s report provides evidence that the student has selected, recorded, processed and **interpreted** the data in ways that are relevant to the research question and can support a conclusion.

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| **Mark** | **Descriptor** |
| 0 | The student’s report does not reach a standard described by the descriptors below. |
| 1–2 | * The report includes **insufficient relevant** raw data to support a valid conclusion to the research question. * Some **basic** data processing is carried out but is either too **inaccurate or too insufficient to lead to a valid** conclusion. * The report shows evidence of little consideration of the impact of measurement uncertainty on the analysis. * The processed data is incorrectly or insufficiently interpreted so that the conclusion is invalid or very incomplete. |
| 3–4 | * The report includes relevant but incomplete quantitative and qualitative raw data that could support a simple or partially valid conclusion to the research question. * Appropriate and sufficient data processing is carried out that could lead to a broadly valid conclusion but there are significant inaccuracies and inconsistencies in the processing. * The report shows evidence of some consideration of the impact of measurement uncertainty on the analysis. * The processed data is interpreted so that a broadly valid but incomplete or limited conclusion to the research question can be deduced. |
| 5–6 | * The report includes sufficient relevant quantitative and qualitative raw data that could support a detailed and valid conclusion to the research question. * Appropriate and sufficient data processing is carried out with **the accuracy** required to enable a conclusion to the research question to be drawn that is fully **consistent** with the experimental data. * The report shows evidence of full and appropriate consideration of the impact of measurement uncertainty on the analysis. * The processed data is correctly interpreted so that a completely valid and detailed conclusion to the research question can be deduced. |
| **Moderator’s award**  3 | **Moderator’s comment**  Sufficient raw data is presented. Qualitative observations are not relevant.  The processing seems heavily guided by the simulation.  The graphical analysis is correct though the trend line through the data should not be straight. The scatter plots are presented separately which is fine, but use a different scale, which makes comparisons difficult.  R2 values are given for the best fit lines though they are not discussed. A correlation coefficient is calculated that has some validity, though again it is not really discussed from the point of view of uncertainties. The measurement uncertainties are not discussed at all.  The interpretation of the processed data is limited and the plateaus that are appearing at high light intensities are ignored. |

**Evaluation**

This criterion assesses the extent to which the student’s report provides evidence of evaluation of the investigation and the results with regard to the research question and the accepted scientific context.

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| **Mark** | **Descriptor** |
| 0 | The student’s report does not reach a standard described by the descriptors below. |
| 1–2 | * A conclusion is **outlined** which is not relevant to the research question or is not supported by the data presented. * The conclusion makes superficial comparison to the accepted scientific context. * Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are **outlined** but are restricted to an **account** of **the practical** or **procedural issues** faced. * The student has **outlined** very few realistic and relevant suggestions for the improvement and extension of the investigation. |
| 3–4 | * A conclusion is **described** which is relevant to the research question and supported by the data presented. * A conclusion is described which makes some relevant comparison to the accepted scientific context. * Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are **described** and provide evidence of some awareness of the **methodological issues** involved in establishing the conclusion. * The student has **described** some realistic and relevant suggestions for the improvement and extension of the investigation. |
| 5–6 | * A detailed conclusion is **described and justified** which is entirely relevant to the research question and fully supported by the data presented. * A conclusion is correctly **described and justified** through relevant comparison to the accepted scientific context. * Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are **discussed** and provide evidence of a clear understanding of the **methodological issues** involved in establishing the conclusion. * The student has **discussed** realistic and relevant suggestions for the improvement and extension of the investigation. |
| **Moderator’s award**  2 | **Moderator’s comment**  The conclusion is supported by the data, but it is not discussed. There is no apparent reference to the scientific context. No strengths of the investigation are considered. The relevance of the limitations that have been identified are not clear. Their relative impact is not discussed.  The improvements proposed are not precise and no extension is proposed. |

**Communication**

This criterion assesses whether the investigation is presented and reported in a way that supports effective communication of the focus, process and outcomes.

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| **Mark** | **Descriptor** |
| 0 | The student’s report does not reach a standard described by the descriptors below. |
| 1–2 | * **The presentation of the investigation is unclear, making it difficult to understand the focus, process and outcomes.** * The report is not well structured and is unclear: the necessary information on focus, process and outcomes is missing or is presented in an incoherent or disorganized way. * The understanding of the focus, process and outcomes of the investigation is obscured by the presence of inappropriate or irrelevant information. * There are many errors in the use of subject-specific terminology and conventions\*. |
| 3–4 | * **The presentation of the investigation is clear. Any errors do not hamper understanding of the focus, process and outcomes.** * The report is well structured and clear: the necessary information on focus, process and outcomes is present and presented in a coherent way. * The report is relevant and concise thereby facilitating a ready understanding of the focus, process and outcomes of the investigation. * The use of subject-specific terminology and conventions is appropriate and correct. Any errors do not hamper understanding. |
| **Moderator’s award**  3 | **Moderator’s comment**  The screen shots are useful, especially as the simulation is password protected. The table headers need more information.  The work is for the most part relevant and concise.  Uncertainties are used in the data, though their format is unorthodox.  Scientific names are used. |