Advanced Higher Biology: example project plan with commentary

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Introduction

This document provides an example plan for the Advanced Higher Biology project and commentary that explains the strengths and areas for development of each aspect of the plan.

Example project plan

Colour of light and the growth of pea plants

Aim

To investigate if the colour of light affects the growth of pea plants.

Hypothesis

Pea plants will grow most in blue light.

Overview

Independent variable: colour of light plants are grown under.

Dependent variable: growth of pea plants.

Pea seeds will be germinated by placing them in petri dishes containing moist paper towels until a root and shoot is visible. The seeds will then be planted in pots until they are approximately 5 cm above the soil. The entire plant in its pot will then be placed in an upside-down box that has had its top removed and replaced with cellophane of a particular colour. The colours that will be used are red, blue, green, and yellow. A colourless filter (clear cellophane) will also be included to act as a control. The plants will be left to grow, and their heights will be recorded approximately every second day for 14 days. The height will be obtained using a ruler or metre stick placed at the base of the pot. The height will be taken as the highest point of the plant.

Pilot study

It is important to have plants with the same approximate starting height, so a pilot was carried out to find the number of seeds that needed to be germinated and potted to give sufficient plants for repeats at each colour of light. Thirty seeds were set up in petri dishes, of which only 22 germinated. These were transferred to pots to grow initially to a suitable height, as described. The height of the pea plants after five days' growth was found to be variable. It was also noted that it was quite difficult to accurately measure the heights of the plants as they didn't always grow straight. As a result, it was decided to also count the number of leaves on each plant and to measure each plant's dry mass at the end of the growing period (by drying to constant mass). Because of the difficulty getting plants of exactly the same height, the starting height of each plant will be recorded and used to calculate percentage increases in height.

Controls

The plants grown in the box covered with colourless cellophane will act as a positive control as they should be receiving all wavelengths of visible light.

Confounding variables

- All plants will be watered with an equal volume of water every second day. The volume added will be measured using a measuring cylinder.
- The boxes will all be placed on the same bench in the classroom where the experiment is carried out to ensure the temperature and light intensity is approximately the same for each.
- The height of the plants will be measured from the bottom of the pot, so all plants will be planted in pots of the same size.
- The germinated seeds will all be planted at the same depth of soil. A marked lollipop stick will be used to find the same depth for each seedling.
- All seedlings will be planted in compost from the same bag.

Sample size/repeats

Two plants will be used for each colour (two plants in each box).

Independent replication

Once the first run of the experiment is complete, a second run will be set up using a new batch of seeds. The second run of the experiment will be carried out in the same way as the first.

Data

Data from all repeats and replicates will be used to calculate mean values for percentage change in height, number of leaves, and final dry mass for each colour of light. This data will be plotted on bar graphs.

Commentary on example project plan

Planning consideration	Commentary
Aim	The candidate clearly states the aim in terms of the independent and dependent variables.
Hypothesis	The hypothesis does not make a general statement relating to the aim. It is, therefore, a prediction about the effect of a particular colour.
Pilot study	The pilot study is acceptable. It resulted in the candidate making changes to inform their final procedure, which will improve the measurement of the dependent variable.
Appropriateness of procedure	The procedure the candidate describes is appropriate. It could allow them to achieve their aim.
Controls	The candidate identifies the colourless cellophane as a positive control (presumably because they think plants should grow 'normally' under that, since it allows all wavelengths of light to reach the plant). However, they do not make reference to a negative control, nor give any justification to explain why they consider a negative control unnecessary.
Confounding variables	The candidate is correct to consider the soil moisture as a confounding variable. Measuring height from the base of pots of the same size is also sensible. However, the consideration they give to the control of temperature and light intensity is inadequate. If they position the plants on a bench rather than under a light bank, they cannot assume temperature and light intensity will always be equal at all points. They do not indicate that they plan to take any measurements to monitor the extent of the variation. Randomising the positions of the plants would help them minimise any positional effect of these confounding variables. When carrying out experiments like this with coloured filters, it is important to measure, and take account of, any differences in the amount of light that passes through the different filters.

Planning consideration	Commentary
Sample size/repeats	Two plants in each colour of light would be the minimum acceptable for candidates to achieve the mark for appropriate sample size. (See section 3e in the detailed marking instructions.) However, this small sample size may not generate sufficient data for meaningful analysis and discussion of the results, which may not allow the candidate to draw valid conclusions.
Replicates	The candidate's plan includes a second run, carried out at a different time using a new batch of seeds. This is acceptable and would gain the candidate the mark for describing independent replication and providing a separate data set. (See section 3f in the detailed marking instructions.) Candidates should be aware that independent data sets with very different means or ranges may indicate an issue that could impact the validity of conclusions.
Complexity, creativity, and accuracy	The candidate will have to manage and organise a large number of plants. Devising an appropriate randomisation procedure would add to the complexity. Designing and making the boxes shows creativity. As a result of the pilot experiment, the candidate realised that simply measuring height may not be accurate, and they modified their procedure to include dry mass, which should provide an accurate measure of growth.
Data	The candidate's plan to pool raw data from all repeats and replicates to calculate mean values is appropriate and is a requirement as explained in the detailed marking instructions. However, this might provide quite limited scope for discussion and evaluation. They might consider other ways to present their data for further analysis. They might also consider using some simple statistical analysis.