Examples of problem-based learning approaches in VCE Environmental Science

A problem-based learning environment is conducive to linking scientific concepts to examining science-based issues in society. Scenarios can be developed from local issues, fictional case studies or case studies reported in scientific journals, as illustrated in the following example.

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| **Step 1: Define the question / scenario / problem carefully: what are you trying to find out?** |
| **Case study: Rock concert dilemma**A small town was renowned for its rock concerts. The rock concerts had been organised on a weekly basis and scheduled every weekend for the last five years. Population surveys revealed that the town population doubled during weekends and local businesses reported significantly increased trade. The local bird-watching club, however, published a report that summarised observational findings over a ten-year period that indicated that populations of an indigenous bird species had declined to almost endangered levels. Members of the club noted that bird-calls could not be heard during rock concert performances and suggested that bird-mating rituals were disrupted by the concerts’ noise. In its annual report the local council reported significant littering issues, both at the concert venues and in a stream that ran adjacent to the concert venue. The local doctor wrote an article in the town’s newspaper reporting that cases of deafness in patients had increased significantly since the rock concerts began.**Student task**: Propose credible resolutions for the issues identified in this case.  |
| Step 2: Refine the question/ explore possible options/ determine what other information may be required(class brainstorming) | Step 3: Plan the actual investigation/narrow your choices(class consensus) | Step 4: Test ideas, obtain further information (group and/or individual) |
| Step 5: Make recommendations that draw upon discussions/research/experiments, including specific scientific terminology, and taking into account the knowledge and values of different stakeholders. |
| Note: Problem-based scenarios do not necessarily have a single solution. |

A problem-based learning approach can also be used to develop specific key science skills. The skills should link to relevant study design content. The following example focuses on the skill of hypothesis formulation.

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| **Step 1: Define the question/scenario/problem carefully: what are you trying to find out?** |
| **Student question**: Do fertilisers improve soil?**Task**: This research question is too broad. The word ‘improve’ needs clarification. Which particular properties of a soil would be investigated? Would the ability of a soil to absorb water or nutrients relate to improvement, or does the improvement relate to increased crop growth? Once this is clarified, a testable hypothesis can be developed. |
| Step 2: Refine the question/explore possible options(class brainstorming)**Possible responses:**Controlling variables:* Does it matter which type of fertiliser is used?
* Does it matter which type of soil is used?
* What other conditions need to be controlled?

Question is too broad in terms of ‘improve’. How will the term ‘improve’ be understood in this investigation?An ‘improved’ soil could result in:* improved growth of plants
* presence of more earthworms
* increased soil moisture so that plants can access water
* more granulated soil texture/ increased water permeability rates to allow nutrients and water to move into plants more easily
* particular pH for growing different types of plants
* increased percentage of organic matter
* increased nutrient content

Other issues:* Will ‘improve’ relate to all types of plants?
* Will ‘improve’ relate to all types of soils?
 | Step 3: Plan the actual investigation/ narrow your choices(class consensus)**Possible responses:**Need to identify dependent and independent variables and control other variables.Independent variable (being selected) relates to the nature of the fertiliser and how the soil is treated:* a particular type of soil may be tested, or multiple experiments could be set up to test different types of soils
* type of fertiliser could be specified (for example, garden manure, commercial fertilisers) or multiple experiments could be set up to test different types of fertilisers

Dependent variable (being measured) relates to the characteristics of the soil improvement that can be measured and could be:* number of earthworms
* amount of organic matter
* soil porosity
* water permeability

Control of variables is dependent on selected independent and dependent variables.  | Step 4: Test ideas and obtain further information(group and/or individual)**Possible responses:** * Hypothesis example: ‘If a soil’s water permeability is directly related to the amount of garden compost it contains, then soils treated with higher amounts of garden compost will have higher water permeability rates than soils treated with lower amounts of garden compost.’ (A further question associated with this hypothesis is whether increased permeability results in better plant growth.)
* Not all hypotheses are testable and not all variables can be controlled for some experiments.
* For this problem, students generate possible hypotheses; provide feedback on each other’s hypotheses; modify own hypotheses.
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| Step 5: Write a conclusion that draws upon discussions/research/experiments, including discussion of scientific terms, control of variables and evaluation of experimental methodology. |
| Note: This class problem-based learning approach can be used to generate different questions for students to investigate, particularly for experimental investigations.  |