VCE Chemistry

Examples of problem-based learning approaches in VCE Chemistry

A problem-based learning environment is conducive to linking scientific concepts to examining science-based issues in society. Scenarios can be developed from actual research studies reported in scientific journals, local scenarios or issues, an imaginary scenario, an interesting chemical phenomenon or a fact-based or fictional case study, as 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: The non-sparkling diamond** **Problem brief:** An insurance company has received a claim for $15,000 to replace a 2-carat diamond ring that a female passenger in a car claimed had been internally shattered when the car was involved in a collision with another car. The passenger claims that the diamond no longer shines as brilliantly as it did before the accident and wants to purchase a replacement diamond. In her claim, the passenger states that she has had a quote for $25,000 as a replacement ring and can sell her ‘shattered’ ring for $10,000. The passenger’s jeweller has submitted photographs that show the diamond has an ‘inclusion’. The insurance company has approached your chemistry class to investigate whether it is possible that a diamond can be shattered in a car accident, and to recommend whether the claim is legitimate and should be paid out.**Student task**: Draw on chemistry concepts related to covalent bonding to develop a model or simulation that demonstrates to a non-chemistry expert what would be required for a diamond to ‘internally shatter’, and to prepare a report that includes a recommendation about the legitimacy of the insurance claim.  |
| **Step 2**: Refine the question/ explore possible options/ determine what other information is required(class brainstorming) | **Step 3**: Plan the actual investigation/narrow your choices(class consensus) | **Step 4**: Test ideas, obtain further information, build and evaluate models(group and/or individual) |
| **Step 5**: Write a report and present a model that draws upon relevant discussions/research/experiments, including specific scientific terminology, in response to the brief. |
| Note: problem-based scenarios do not necessarily have a single solution |

A problem-based learning approach can also be used to develop specific science skills. The skills should link to relevant chemistry 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? |
| **Question**: What factors affect crystallisation?**Task**: This research question requires refining with a narrower focus to develop a testable hypothesis. |
| **Step 2**: Refine the question/explore possible options(class brainstorming)**Possible responses:**Crystals generally grow by the ordered deposition of solute particles onto the surface of a pre-existing crystal. Background research may be undertaken to explore possible factors that affect crystallisation before a hypothesis can be formulated. General issues for consideration include:a. Solvent * polarity of the solvent.

b. Solute and solution* composition of solute (for example, simple ionic solid; ‘double’ salt, molecular solid – polar or non-polar)
* solubility of solute in solvent
* degree of saturation of solution (for example, saturated versus supersaturated).

c. Nucleation* number of nucleation sites
* type of nucleation site (for example, small seed crystal suspended into the solvent; seed crystals on base of container; scratched glass surface of container).

d. Physical conditions over the time allowed for crystal growth * initial temperature of solvent
* rate of cooling of solution
* intensity of light
* total volume and surface area of solvent
* degree of stillness (for example, whether vibrations, draughts or other disturbances occur)
* humidity of the surrounding air (in the case of water as the solvent).

e. Total time available for crystal growth* number of days.
 | **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 a selected factor relating to the set-up for the crystallisation process to occur and could be:* number of nucleation sites
* temperature
* light intensity
* size of nucleation site
* type of nucleation site
* saturation level of solvent
* nature of solvent.

Dependent variable (being measured) relates to ‘nature of the crystal’ that is formed and could be:* size of crystal
* crystal shape – degree of symmetry.

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, in nature, rocks that have cooled quickly only contain small mineral crystals, then the slower the rate of cooling of a solution, the larger the crystal that is produced.’
* 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.  |