Chemistry Practical Learning Portfolio Scheme (2025/26)

Hands-on and Minds-on Practical Activities

Practical activity is an essential component of chemistry learning. It serves not only to develop students' scientific knowledge and skills, but also to deepen their understanding of the nature of science. More specifically, practical activity can achieve the following outcomes:

- Developing scientific inquiry and problem-solving skills
- Acquiring experimental techniques and manipulative skills
- Appreciating the construction and validation of scientific knowledge
- Strengthening conceptual understanding through experiential learning
- Fostering sustained interest and motivation in learning science

These outcomes, however, depend on the quality of the practical activities. Superficial learning activities that focus solely on following procedures or recalling expected results often fail to achieve meaningful learning outcomes. To enhance the quality of practical activities, teachers may integrate higher-order thinking questions (HOTQs) that engage students in scientific reasoning and logical thinking.

Higher-order Thinking Questions (HOTQs)

HOTQs are designed to move learning beyond rote memorisation and factual recall. They challenge students with tasks that require them to apply, analyse, evaluate, and construct knowledge based on their observations and collected data. Some examples includes:

- Analysing and explaining experimental observations and results;
- Identifying and explaining potential sources of error or uncertainty in experimental procedures;
- Suggesting improvements to the experimental design or procedures to enhance accuracy, safety, or reliability;
- Proposing modifications or extensions of the experiment to explore new scientific questions;
- Applying scientific concepts and skills to unfamiliar or real-life contexts; and
- Interpreting and analysing hypothetical or real experimental data to draw evidence-based conclusions.

By contrast, if practical activities consist only of conventional questions that rely on rote memorisation without requiring students to understand the experiment or apply scientific inquiry skills, the effectiveness of practical activities in promoting higher-order thinking will be very limited.

Example of HOTQs

Experiment: Testing for the Presence of Chloride in Table Salt

Conventional Questions	Higher-order Thinking Questions
• What is the expected observation if a sample contains chloride ions? • Write the ionic equation for the formation of the precipitate. • Why is dilute nitric acid used in this experiment?	• Can we confirm that chloride is the only anion present in the table salt sample based on the experimental results? • Does the formation of a white precipitate always indicate the presence of chloride ions? Why or why not? • Suggest another acid that could replace nitric acid in this experiment. Justify your choice. • Does it matter if nitric acid is added after the silver nitrate solution? Explain your answer. • How would the results be affected if sulphuric acid was used instead of nitric acid? Predict and explain. • List some possible reasons why no precipitate was formed. • In what real-life situations is it important to detect chloride ions accurately? Give an example and explain.

Enhancing Minds-on Learning Experience with AI-assisted Tools

Appropriate use of AI tools to support practical activities can promote higher-order thinking. Below are some suggestions for using AI in practical learning:

- Generating higher-order thinking questions based on practical context or data for teachers' reference and adaptation;
- Providing instant feedback on students' reasoning, hypotheses, or data interpretation;
- Assisting students in the visualisation and analysis of complex data sets;
- Simulating experimental variations to help predict outcomes;
- Offering real-time prompts for students to guide error analysis or encourage reflective thinking; and
- Recommending real-life applications or extensions linked to the practical tasks.

Teachers should be aware that AI-generated content is for learning and teaching reference only. Before using such content, teachers should conduct fact-checking and remind students of key points to note when using AI (e.g. protecting personal privacy, adhering to academic integrity, and avoiding over-reliance on AI). Teachers must adapt AI-generated content according to curriculum documents, assessment requirements, and academic integrity. At the same time, it should be noted that AI tools should be regarded as a tool for supporting and inspiring thinking, not as a substitute

for professional judgement or students' independent thinking. Furthermore, not every learning activity requires the use of AI.

To support the design of effective practical activities that promote hands-on and minds-on engagement, teachers may use Generative AI and other suitable tools to assist in preparing HOTQs and learning tasks for chemistry practical activities. These AI tools can help teachers design questions that challenge students to apply their knowledge, reason scientifically, and think logically about practical tasks.

Suggested Steps for Using Generative AI to Prepare HOTQs:

1. **Train AI with examples**
   - Share a small set of example HOTQs so the AI learns the format, reasoning depth, and HKDSE-level style.
   - Example prompt for training:

> *I need to create higher-order thinking questions of chemistry practical activities for my students. Please study the style, depth and reasoning level of the following higher-order thinking questions before you generate new ones for my experiment.*
>
> - *Can we confirm that chloride is the only anion present in the table salt sample based on the experimental results?*
> - *Does the formation of a white precipitate always indicate the presence of chloride ions? Why or why not?*
> - *Suggest another acid that could replace nitric acid in this experiment. Justify your choice.*
> - *Does it matter if nitric acid is added after the silver nitrate solution? Explain your answer.*
> - *How would the results be affected if sulphuric acid was used instead of nitric acid? Predict and explain.*
> - *List some possible reasons why no precipitate was formed.*
> - *In what real-life situations is it important to detect chloride ions accurately? Give an example and explain.*

2. **Provide details of practical task**

   Upload the practical worksheet or input the practical procedures into the GenAI platform.

   What to Include:

   - **Title and Objectives:** What is the experiment about?
   - **Chemicals and Apparatus:** What materials are used?
   - **Procedure:** What are the step-by-step instructions?
   - **Expected Results:** What observations or data should students record?

3. Generate HOTQs with an effective prompt

Use a clear, detailed prompt that specifies exactly what is needed. The template below can be adapted by teachers as required.

> *Refer to the practical worksheet attached or practical procedures input, I am designing higher-order thinking questions (HOTQs) for a secondary school chemistry practical activity aligned with the HKDSE Chemistry Curriculum.*
>
> *Based on what you learned about the style, depth and reasoning of the HOTQs and the experiment details I provided earlier, please generate 10 HOTQs with sample answers and organised under the following categories and written in a similar style to the examples provided:*
>
> 1. *Analysis & Explanation – students explain experimental results or observations.*
> 2. *Error & Uncertainty – students identify and explain possible sources of error.*
> 3. *Improvement & Extension – students suggest improvements or propose new experiments.*
> 4. *Application & Data Interpretation – students apply concepts to real-life situations or interpret given/hypothetical data.*
>
> *Requirements for each question and answer:*
> - *Use clear HKDSE-level chemistry terminology.*
> - *Require logical reasoning and scientific explanation, not memorisation.*
> - *Keep answers concise and accurate (2–5 sentences each).*
>
> *Format the output as:*
> *Category → Question → Sample Answer*

4. Review and customise the output

Review the AI-generated questions and answers. Revise the prompt if needed, try alternative phrasing, or use a different platform. Teachers may also develop their own higher-order thinking questions inspired by the AI's suggestions.

<u>What to do:</u>

- **Check for Accuracy:** Are the chemical concepts and answers correct?
- **Adjust the Difficulty:** Are the questions too easy or too difficult for students?
- **Further Customise:** Modify the wording to match the teaching style or combine ideas from different questions to create unique HOTQs.