Enhancing student engagement: A case study in electrosynthetic organic chemistry

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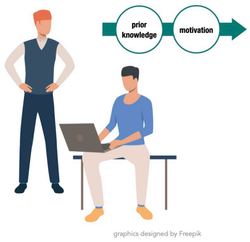
In the digital age, fostering student engagement in **interdisciplinary subjects** like electrochemistry requires innovative approaches that blend **hands-on experiences** with **modern technology**. This presentation discusses a project supported by **Teaching Innovation Fund** from the Faculty of Science (2022–2023) that aimed to enhance learning by introducing electrosynthetic organic chemistry to undergraduate students. Using innovative pedagogy and the state-of-the-art "*ElectraSyn 2.0 Pro*", the project bridges the gap between theoretical learning and practical application. Students actively involved not only through **experimentation** but **co-designing activities** that emphasise **sustainable practices**.

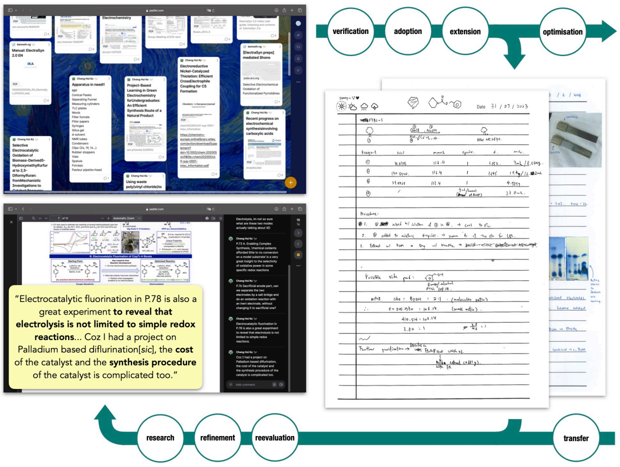
Pedagogy

Student-as-partners

Senior-year undergraduates or **graduands**, with suitable guidance, are best positioned to **identify gaps** and elements lacking in current curriculum

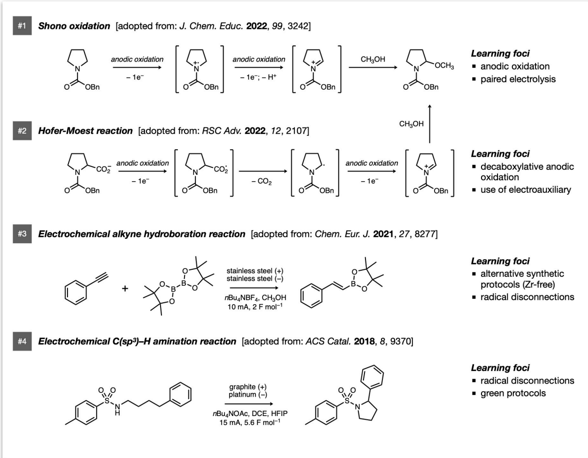
With the right participants recruited, this can naturally extend into **near-peer teaching**





Student–partners are invited to brainstorm ideas, provide rationale, perform literature searches, adopt protocols, and test the feasibility of these practicals as teaching activities (*transferable research skills*).

Student–partners share research articles they find interesting and/or consider relevant on *Padlet*. The reflection highlighted above clearly demonstrates how the student connected the new finding with their past research experience (*schema*) and identified a significant advantage in the current procedure.



Practical criteria for effective teaching activities:

- **Structure**: Introduces a specific concept in electrochemistry
- **Chunking**: Self-contained within a typical 4-hour undergraduate lab session
- **Cognitive load**: Manageable for undergraduates (~100 mg scale) to avoid unnecessary complexity
- Safe to operate

Four activities meeting all the criteria have been developed to date.

Extra-curricular learning activity: stress-free and authentic

Junior-year undergraduates often find traditional methods of knowledge delivery dry and unengaging, particularly when they lack the foundational understanding needed to enjoy learning the new material (*zone of proximal development*).

A strong focus on achieving high grades can also shift students' priorities away from deep engagement and genuine intellectual curiosity. As a result, students may avoid interdisciplinary studies and choose courses based on perceived grading easiness.

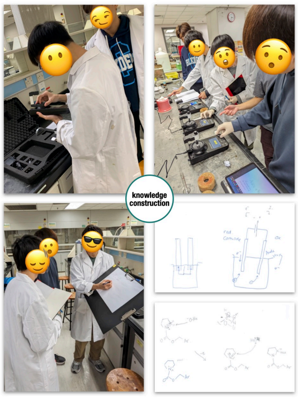
Pre-event questionnaire

Q1. Year of study:
This information helps to better pair or group participants.

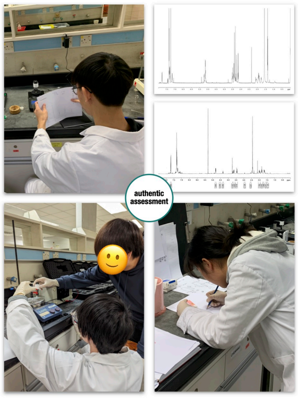
Q2. Courses previously enrolled in:
Multiple-choice options for relevant courses to gauge **prior knowledge**.

Q3. One thing you would like to learn in this try-out:
This open-ended question assesses the **intrinsic motivation** of participants, which is crucial for **group dynamics**. Additionally, it will be used in combination with a **post-event questionnaire** to evaluate the **effectiveness** of the teaching activity.

Given the diverse academic background, it was essential to assess students' prior knowledge and provide adequate scaffolding. As expected, the pre-event questionnaire revealed varying expectations based on year group and prior exposure; e.g., a Year 2 participant who had not enrolled in any relevant courses wanted to know "how to manipulate the device", while a Year 4 student was more specific, seeking to understand "the manipulation of *ElectraSyn* in understanding the cyclic voltammetry of chemical reactivity". This feedback guided the design and implementation of appropriate scaffolding, such as additional visuals, molecular models, and demonstrations.



"Plug-and-play" functionality made setup easy, allowing students to focus on learning new concepts without added stress. The relaxed environment also encouraged peer teaching, as seen in the evolution of diagrams drawn by participants (top sketch). The initial drawing on the left shows one student attempting to recall from memory but not getting it quite right. With help from a peer, the diagram improved, eventually evolving into the version on the right, where a third participant made additional modifications. They also successfully figured out the mechanism of Shono reaction by applying theory learnt from organic chemistry to electrochemistry (bottom sketch).



With hands-on experimental work, there is an inherent assessment component: whether the intended product has been successfully synthesised. Students were introduced to analytical techniques, such as thin-layer chromatography and nuclear magnetic resonance, in a meaningful context, allowing them to monitor reaction progress and identify products. This exposure presented real-life analytical challenges and enhanced their problem-solving skills. Although participants are not required to produce a laboratory report, they must record procedures and observations during the practical, emphasising the importance of formal documentation in research and providing an authentic experience.

Post-event questionnaire

Q1. I enjoyed the try-out… [Strongly agree / Agree / Disagree / Strongly disagree]

Q2. Did the contents meet your expectations? [Exceeded my expectations / Met my expectations / Did not meet my expectations]

Q3. State one thing you have learned from the try-out.

Q4. I will join another session of these try-outs (with different contents)… [Strongly agree / Agree / Disagree / Strongly disagree]

Q5. Other comments / suggestions for improvements?

extension & transfer

"Pretty interesting experience! It's really good to have other chances to do experiments **out of class** and being **non-credit bearing**. It would be great to have **more opportunities** to participate in this kind of activities, it could be from different themes of chemistry, so **to have fun and learn more**."

"We got a brief intro to the NMR and cyclic voltammetry and would **get to know more next time**! TLC, meanwhile, provided a hands-on experience on performing rapid test to examine the nature of the reaction. This **encouraged us to develop a skill** in experiment backtracking and utilize multi-dimensional thinking."

The post-event questionnaire results were highly encouraging, with 100% of respondents indicating they "strongly agree" that they enjoyed the session. Half felt their expectations were met, while the other half felt they were exceeded. Participants particularly valued the authentic approach to practical sessions, where they learned to monitor reaction progress rather than relying solely on standard lab manual instructions. Notably, there was strong enthusiasm for non-credit, explorative activities outside the formal curriculum. The questionnaire responses also sparked further interest, leading to ongoing email exchanges and continued learning.

Reflections

- In an era dominated by digital resources, there is a growing need for university education to offer unique learning experiences that go beyond what platforms like YouTube can provide. While digital tools such as visualisation aids (e.g. animations, graphics, 3D printing) offer valuable support, universities must carve out a niche that emphasises hands-on, engaging activities that cannot be replicated online.
- Digital tools present valuable opportunities but also challenges, as students may gain a false sense of mastery without real engagement. For instance, when asked about prior exposure to electrosynthetic chemistry, one student recalled a YouTube video but could not remember details, illustrating a common issue: students consume content but may not retain it.
- When students prioritise high grades over deep engagement, it suppress intrinsic motivation, limit intellectual curiosity, and discourages interdisciplinary studies. At HKU, grade pressure can drives students to choose courses based on perceived grading ease rather than genuine interest, especially for those aiming to maintain pristine transcripts for further education.
- University curricula are slow to adapt, often lagging behind technological advancements. While fields evolve, students can be trapped in outdated courses that do not equip them with relevant skills. Extracurricular learning activities offers a flexible solution, enabling engagement with emerging topics outside the standard curriculum. These activities foster motivation, a culture of continuous learning, and complement traditional courses, bridging foundational knowledge with the adaptability needed in today's fast-paced landscape.

Acknowledgement

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