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10 Guiding principles for learning in the laboratory

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Laboratory work in chemistry has been extensively researched in the last decade but the gap between research and practice is still broad. This Perspective shares 10 guiding principles relating to university laboratory education, drawing on research over the last decade. Written with an audience of practitioners in mind, the Perspective aligns with Hounsell and Hounsell's congruence framework, so that the 10 principles consider all aspects of the laboratory curriculum: design, teaching approaches, and assessment approaches as suggested by Biggs, but additional contextual factors relating to teaching context, backgrounds of students and their support, and overall laboratory organisation and management. After discussing the rationale for each guiding principle, examples of approaches are given from recent literature along with prompts to help enact the guiding principle in practice.

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Introduction

It has been a productive decade for research on teaching and learning in chemistry laboratories. Major programmes of activity have reported conceptualising the laboratory as a space for meaningful learning (Bretz *et al.*, 2013), discussion of intended goals (George-Williams *et al.*, 2018b; Seery *et al.*, 2019b; Agustian *et al.*, 2022a), reassertion of the role of preparation activities (Agustian and Seery, 2017), incorporation of more opportunities for experimentation (Seery *et al.*, 2019a; 2019b; 2019c; Gorman *et al.*, 2021), teaching and learning of practical skills (Towns *et al.*, 2015; Hensiek *et al.*, 2017; Seery *et al.*, 2017), better consideration of learning in advanced practical settings (Schmidt-McCormack *et al.*, 2017), an in-depth exploration of lived experience of students in laboratory contexts (DeKorver and Towns, 2015; DeKorver and Towns, 2016; Galloway *et al.*, 2016; Jeørgensen *et al.*, 2023; Finne *et al.*, 2023) and a renewed emphasis of consideration about the purpose of practical work (Bretz, 2019; Seery, 2020) – the latter caused in no small part by the COVID-19 pandemic (Kelley, 2021). These have all combined to give extensive insight into designing, teaching, and assessing the laboratory component of chemistry curricula.

While those researching learning in laboratories can be glad of this renewed interest and extensive outputs, the

predominance of the pandemic in overwhelming much of the discourse relating to learning and teaching means that much of this research into laboratory education may not yet have influenced teaching practice. The laboratory literature – already vast – has swollen further in the last decade, with substantial progress in our understanding of laboratory learning environments and students' experience of them. This Perspective aims to bring a summary of sorts to this past decade – and the learning we can take from it – in a format useful to the broader community of educators. Connor and Baker (2023) recently argued that there is an onus on chemistry education researchers to work with practice-focussed colleagues and support their engagement with evidence-based practices. Conscious of the challenges of bringing research into practice, we share these outputs by parsing them in the form of “Guiding Principles” for those who are interested in developing or redeveloping their laboratory curriculum and activities. This approach has been successful elsewhere in furthering awareness, dialogue, and action on educational reform (Noedmann *et al.*, 2020). We purposefully remain agnostic to particular laboratory teaching approaches such as those shared by Domin (1999) (inquiry, problem-based, etc.), instead preferring to share suggestions grounded in more general terms. This is partly because faculty may have preconceptions about particular approaches that override the actual teaching and learning principles that underpin them, but more generally because the reality of change is often incremental; changing aspects of laboratory teaching is often more achievable in small iterations than making overall systemic change aligning to a particular paradigm all at once (Mundy *et al.*, 2023). Different actors involved in laboratory work will have different amounts of resource, power, and time

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Principles Of Learning From Laboratory To Field

RS Peters



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Reviewing **Principles Of Learning From Laboratory To Field**: Unlocking the Spellbinding Force of Linguistics

In a fast-paced world fueled by information and interconnectivity, the spellbinding force of linguistics has acquired newfound prominence. Its capacity to evoke emotions, stimulate contemplation, and stimulate metamorphosis is truly astonishing. Within the pages of "**Principles Of Learning From Laboratory To Field**," an enthralling opus penned by a very acclaimed wordsmith, readers embark on an immersive expedition to unravel the intricate significance of language and its indelible imprint on our lives. Throughout this assessment, we shall delve in to the book is central motifs, appraise its distinctive narrative style, and gauge its overarching influence on the minds of its readers.

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