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Science practical work and its assessment: an opportunity to improve learning in a post-AI world

The value

It is generally accepted by scientists that practical work is an essential component of a science degree. Australian science degrees are valued internationally for their hands-on experience in the laboratory or field. These activities allow students to engage with science and the ways in which scientific knowledge is generated in a different mode from lectures or tutorials. Even though many students will not go on to become practicing scientists, laboratory and field work can support general scientific literacy by showing how science is done and providing some basis for evaluating scientific claims. A report to the ACDS in 2009 (Rice et al., 2009) concluded that there was considerable value in practical work for all students, regardless of their career aspirations. In addition to learning about scientific practice, students may also gain transferable generic skills. However, the report also called for the better articulation of the value of practical work, including explicit articulation of learning objectives to both staff and students.

Laboratory learning provides a unique experience, allowing students to integrate the cognitive, psychomotor and affective domains of learning (Bloom et al., 1956). Cognitive and psychomotor learning is linked as students connect theory with practice via performance of various techniques. Students generally enjoy laboratory and field work and value interaction with peers and demonstrators, which addresses the affective domain and promotes cognitive learning. Reinforcement of the different domains of learning supports developing self-efficacy, which underpins success and retention. Students may also gain valuable employability skills such as time management and independence. Surveys and interviews with students find that they recognise a wide variety of learning gains, covering cognitive, psychomotor and affective learning and that they value the unique opportunities provided by the laboratory environment (Cleaver et al., 2025, Enneking et al., 2019, Galloway and Bretz, 2015, Rice et al., 2009).

The threat

In the years since 2009, higher education has seen many changes. There is a greater need than ever for scientists to articulate the value of practical work in undergraduate degrees. In many universities, the experience of the COVID pandemic and subsequent financial constraints has resulted in reductions in the amount of practical work. Laboratory and field work is expensive to support. Online activities and simulations developed during COVID lockdowns provide additional flexibility for students as well as cost-savings. The rise of generative AI has led to calls for learning outcomes to be re-evaluated to provide greater focus on assisting students to gain the skills needed for the post-AI world. It has also challenged the value of many common assessment items, including the lab report. However, the unique value of experiential learning in the laboratory and field cannot be overstated and we should not stand by and let further erosion occur. It is timely to articulate the value of practical work, its role in the curriculum and the potential for assessment that occurs in the lab and field.

The opportunity

While many science academics also value diverse learning gains from practical work (Wilson et al., 2016b), assessment only rarely addresses all three domains of learning. The standard assessment, a formal report, assesses only cognitive learning. To maximise the gains from practical work, it is essential that it is reviewed from the perspective of constructive alignment, ensuring that we are assessing the learning that is valued. While the 2009 call for clear learning outcomes that are explicit to both students and teachers (Rice et al., 2009) has been addressed to a large extent, it is now important to ensure that assessment is fully aligned with valued learning.

A potential advantage of in-person practical work is that it can allow the integration of assessment into practical activities, thus better ensuring integrity of assessment in addition to assessing a broader range of learning outcomes. This addresses the TEQSA recommendation that assessment focus more on process than product (Lodge et al., 2023), so that students' development of skills and knowledge can be directly observed and assessed. This contrasts to a laboratory report where it is now impossible to determine how much the student has contributed to the report and how much input there has been from AI. A further concern is that reports can be written from provided or shared data so there is no necessity for the student to perform the experiment themselves. While report writing is still of value, it is important that the unique aspects of laboratory work are also recognised in learning outcomes and assessment.

The future

Tertiary science education must change in response to the spread of AI and in science, we have the advantage that many of the skills taught must be performed in person – those in the lab and field. There are many examples of in-person assessment that can better address cognitive, psychomotor and affective learning that are already being used in practical work or can easily be applied to the laboratory or field. An additional advantage is that students often report improved satisfaction because of the immediate feedback on their learning. The table below provides some examples of alternative assessment methods that capitalise on the in-person experience. Many of these activities could contribute to writing a report, where students use the feedback from the in-person assessment to complete a report, or form part of a learning portfolio. This could also include structured reflection, for example annotating text to explain its purpose (Fox, 2025) or responding to targeted questions that prompt reflection on specific aspects of the practical experience (Wilson et al., 2016a) to assist students in identifying learning gains.

Assessment activities that can be done in the lab or field

Assessment	Description	Reference
Practical exams	Students are assessed on their ability to follow a practical procedure or on the result obtained	Di Trapani and Clarke, 2012 Hancock and Hollamby, 2020
Mastery learning and competency assessment	As above, but students have multiple attempts and must achieve competency to pass	McGaghie, 2015 Competency Assessment and Grading | UNSW Staff Teaching Gateway
Interactive oral assessments	Students are questioned on their understanding of procedures and results, can be done in the lab or field.	Interactive Oral Assessments Davey et al., 2025 Staff-preparation-guide-for-IOA.pdf
Structured assessment before, during and after labs	Students work through a scaffolded set of activities covering process and analysis. This could include completing a lab book or similar template.	Arthur et al., 2016
Group presentations or posters	Students work together to present results of practical work	Guide to conducting Group Work - ACDS Rauschenbach et al., 2018, Logan et al., 2015
Peer review of data generation and analysis activities	Students use practical time to generate graphs and other analysis and then review each other's work by completing a template	Tonissen et al., 2014

There are several challenges arising from changing assessment of practical work. Staff who are unfamiliar with alternative assessments may need support and professional development opportunities. Students need to know how assessment aligns with learning outcomes and why particular approaches are used and thus clear communication of expectations is essential. Demonstrator training must incorporate guidelines and expectations for any marking in which they participate.

A final challenge for the future is the integration of practical work and its assessment into degree structures that might allow programmatic assessment or accreditation. Either approach might ensure that practical work retains a prominent position in the curriculum. There are significant challenges in such approaches to broad degrees, such as the Bachelor of Science. However, there may be scope to align accreditation or program-aligned assessment to majors within the degree, allowing for disciplinary differences in the nature and amount of practical work.

ACDS supports the maintenance of practical work as an essential curriculum component because of its unique value in fostering holistic learning. The value of laboratory and field work in the science curriculum can be enhanced by capitalising on the current opportunity to re-design practical assessment. Restructured practical work and assessment has the potential to provide a more secure, meaningful and comprehensive evaluation of student learning, adding value to a science degree.

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