Assessing wicked competences in undergraduate science research projects (0216)

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Authentic experiences of research are often presented as valuable elements of undergraduate science programmes, providing opportunities for students to develop critical thinking and a level of professional expertise within their discipline (see, e.g., Brew 2010; Healey and Jenkins 2009; Krause et al. 2008; Laursen et al. 2010). Indeed, much of the learning that is claimed to take place within them may be described as the development of what Knight and Yorke term 'wicked' competences (Knight and Yorke 2008) – the complex competences required to play an effective part in addressing the supercomplex problems (Barnett 2000) that characterise the modern world . But if this is the primary benefit of engaging undergraduates in research, it is incumbent on academics to find ways of both articulating what these competencies consist of, and surfacing evidence for their development. This need is most urgent where research projects are included as formal, graded parts of the curriculum (as is increasingly frequently the case). This paper asks the question: how might academics make professional judgments around successful learning outcomes in relation to wicked competences?

This paper draws on interviews with academics involved in the provision of such experiences (Authors 2015a) and learning logbooks kept by project students (Authors 2015b) to address three questions:

1. What do science academics intend that students undertaking research projects learn, where these projects are undertaken as formal , graded parts of the undergraduate curriculum?
2. Do conventional approaches to project assessment relate clearly and effectively to these intended outcomes?
3. Can bases for professional academic judgments in relation to complex, 'wicked' learning be articulated, and can appropriate evidence be surfaced?

Over the last two decades, increasing attention has been paid to undergraduates' experiences of engaging in academic research, both as institutional strategy and subject for educational research (Brew 2006; Healey and Jenkins 2009; Jenkins and Healey 2005). The drivers of this trend include factors at institutional, national and global levels. On the one hand, institutional uptake is in part motivated by desires to more effectively link the research and teaching activities undertaken within universities – with measurements of academic success mostly focussed on research prowess, a sense that teaching and research are inter-related is important to engaging successful researchers in teaching. On a national level, an emphasis on research as a defining characteristic of higher education even at the undergraduate may help universities to more firmly establish themselves as the primary sites of knowledge production in modern society, in competition with e.g. private sector and government research institutes. On both national and global levels, linking research and learning helps promote universities as the most effective locations for the development of research-related generic skills such as analytical and critical thinking, problem-solving, independence and

creativity (Krause et al. 2008) – skills that when operating together form the 'wicked competences' that are so sought-after by employers and industry (Knight and Yorke 2008).

Drawing on in-depth interviews with academics involved in the provision of undergraduate research projects in the sciences, we identify four categories of intended learning, three of which relate to the development of ways of thinking and being, and so might be described as wicked competences. We suggest that conventional approaches to assessment, which focus on research outputs and rely heavily on intra-scientific forms of communication such as academic journal articles and conference presentations, are fundamentally misaligned with most of these outcomes. We further suggest that the almost exclusive use of such forms of assessment is in part due to institutional discomfort with assessment based on context-dependent judgments informed by subconscious expertise.

In contrast, our interviews show that academics involved in grading such projects feel confident in their ability to make judgments: comments such as 'you're looking for … a bit of spark there' and 'shines out' reflect a reliance on gut feeling or judgments based on unarticulated criteria. There was occasionally explicit resistance to attempts to pin down the criteria on which performance might be judged: 'I think it's like asking what defines a good artist? If you write it down it ceases to be anything meaningful. You know it when you see it, using your professional judgment' (Wilson, Howitt and Higgins 2015a).

This situation shows a strong parallel to the assessment of learning in work-based and professional contexts, where the need to assess professional expertise rather than academic learning raises similar issues. This suggests that a reconceptualization of undergraduate research projects as work-based learning, where the work is that of a research scientist, may be beneficial. Concepts such as 'knowledge-in-practice', situated learning and legitimate peripheral participation can be fruitfully applied to the process-focussed learning and research socialisation that seem to be more valued by academics and students alike. Indeed, the widespread use of reflective practice in work-based learning allows for a more effective focus on process-related learning.

In this paper, we show how structured reflective blogs kept by science project students can reveal examples of independent thinking, creative thinking and a developing sense of themselves as scientists. They also show how these combine as wicked competences that allow students to address the complex problems and uncertainties of research. We identify characteristic patterns of reflection In relation to, e.g., the development of project management skills; drawing inferences from data; creativity and criticality in relation to research design; and experiencing having expertise that indicate the exercise of such competences. We further suggest that these could be used as explicit evidence by academics making judgments for assessment purposes.

At an institutional level, analysis of the blogs from an entire cohort could be used to provide evidence that research experiences support learning of wicked competences and higher order thinking skills, or identify areas where such learning needs greater scaffolding. This might provide evidence on which to justify the continued provision of these rich but resource-intensive learning experiences, and indeed their expansion to a larger fraction of the student body.

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