6 Wicked problem inquiries in higher science education: Philosophical analysis and pedagogical implications

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Abstract

Wicked problems have been characterised by their high epistemological and axiological complexities. These are the kinds of problems that may invade our classrooms because many of them concern many stakeholders, including our students. Several approaches have been developed to address wicked problems in various contexts. However, little is known about how they may translate into educational research and practice. This paper proposes a conceptual framework in which wicked problems are analysed from their ontological, epistemological, and ethical commitments. Chief to the arguments is a focus on epistemic practices that are strongly anchored in but also extend from disciplinary science education. Implications for curriculum development and instruction in higher science education are presented.

Full paper

Recent works in higher education suggest that wicked problem solving entails working within and across disciplines, coming to terms with the complexity and messiness, and engaging diverse stakeholder perspectives (Block ea, 2022; McCune ea, 2021). However, it is still unclear whether, and how, discipline-based higher science education has been playing a role and, indeed, could be empowered to help faculty address wicked problems in their teaching practice. This paper is extracted from a larger work (currently under review in a leading journal) in which I propose a conceptual framework for teaching science using wicked problems as an integral part of university science curricula. The framework incorporates an analysis of wicked problems from their ontological, epistemological, and ethical commitments, employing ideas from philosophy of science. Subsequently, I will argue for a focus on epistemic practices that moves beyond disciplinary science. With higher science education in mind, I will propose relevant methodological and pedagogical implications.

The ‘wicked’ characteristic in the term 'wicked problems' is essentially attributed to the ill-formulated nature of the problems, exacerbated by conflicting findings and perspectives, which often lead to controversy, confusion, and messy solutions. Due to their high complexity, wicked problems pose unprecedented epistemological challenges. For instance, it is difficult to produce reliable knowledge because of conflicting perspectives. Expert and specialised knowledge, which is traditionally revered in its own domain, such as science, is no longer seen as the only authority (Kate ea, 2019). Consequently, teaching knowledge related to wicked problems is equally challenging. Scholars in the field emphasise the importance of reconciliation of opposites (Adam, 2016), open and critical transdisciplinary inquiry (Brown, 2010), and holistic thinking (Lehtonen ea, 2019). Ramification of wicked problems across various layers of socio-economic structures, political ideologies, and planetary sub-systems also create ethical dilemmas. When addressing a wicked problem, what is the right and ethical course of action to take when there are conflicting values between local communities and government organisations, or between science and individuals? In a context where indigenous communities are faced with big corporations, how can power imbalances (ever) lead to equitable solutions? How do we address this in our science teaching?

One of the most salient features of wicked problem inquiries is how knowledge is conceptualised, co-constructed, communicated, and evaluated. In science education, this has been studied primarily as an emerging construct called ‘epistemic practices’ (Kelly, 2018). In my current research in laboratory education, I have been focussing on laboratory work as an epistemic practice (Agustian, 2022), drawing on theories of learning in higher education, critical studies of science as a body of knowledge and ways of thinking, as well as philosophy of mind. The current paper expands the extant line of research on epistemic orientation in higher science education.

In the context of wicked problems, I argue that research on epistemic practices can no longer be confined within monodisciplinary structures and cultures, which typifies traditional higher (science) education. The far-reaching implications of wicked problems, the high system uncertainties and the high stakes decisions required to address them, render traditional approach to curriculum and instruction ineffective. Novel approaches are in dire need to developing curricula and pedagogies that address wicked problems in a way that is strongly anchored in disciplinary science but also engage other disciplines and non-academic perspectives. Creativity, imagination, and intellectual humility are relevant (Brown, 2015; Brown ea, 2010; Pritchard, 2018). The inherently high axiological complexity tied to wicked problems suggests that humanities and arts may prove to be powerful in addressing the ethical conundrums mentioned above.

Curriculum developers in each discipline may revisit their existing curricula first and foremost to identify areas in which a potential wicked problem could be investigated in a transdisciplinary context. They may wish to collaborate with educational researchers and consultants to scaffold this development process. Tradeoffs may need to be made, but the principle of balancing the conceptual, technical, social, and epistemic goals in designing intended learning outcomes applies here. Accordingly, the centrality of problem in the entire discussion on wicked problems implies that instruction could largely benefit from problem-based learning (PBL) pedagogy. In particular, research-based instructional approaches can be discerned from PBL in inter- and transdisciplinary higher education settings (Jensen ea, 2019). Other inductive and investigative frameworks may also be effective, including inquiry-based, context-based, and ultimately research-based teaching frameworks. Whichever is chosen, the focus on epistemic practices within PBL instruction implies that all stakeholders involved in the collective inquiry into the chosen wicked problem should continually reflect on their assumptions, biases, and limitations of knowledge.

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