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The science curriculum: issues, tensions and future prospects

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At its core, science curriculum captures what is seen to be the important knowledge, skills and dispositions to be included in education. However, consideration of what should be in the curriculum brings up a number of tricky questions about values, what is important science knowledge for now and the future, who the curriculum is developed for and how will it be implemented. A number of leading scholars working in the area of science education have contributed to the task of identifying and addressing these fundamental questions. For example, Millar and Osborne's (1998) seminal report, *Beyond 2000: science education for the future* critically examined the aims of science education at a time when science curricula were seen to be little more than an agglomeration of content. The report recommended an approach involving 'explanatory stories', that is, themes that cut across the separate sciences.

During the 25 years since the publication of *Beyond 2000*, discussions about the content of the curriculum and the broad mission of school science have continued (Banner et al., 2012; Fensham, 2013; Fu & Clarke, 2019; Osborne & Dillon, 2012; Osborne et al., 2022). Indeed, science education faces increasingly difficult questions about what is valuable for students to know about science and scientists. The explosion of new knowledge and the development of technology such as generative artificial intelligence in science (Cope & Kalantzis, 2009) continues to raise tensions between the inclusion of older fundamental ideas and more contemporary science discoveries within curricula.

In recent years there has been a focus on the idea of interdisciplinary STEM (however conceptualised) and some attempts to define the competences needed for the twenty-first century (Millar, 2020). In addition, issues of trust, post-truth and misinformation that were present prior to Covid-19 have been amplified as a result of the pandemic and the ongoing and related political instability (Dillon & Avraamidou, 2020; Erduran, 2020; 2022; Osborne et al., 2022). There is also an increasing desire to examine how decolonisation, inequality and social justice should be addressed and whether curriculum decisions have a gatekeeping effect that lock some students out of science (Coll & Taylor, 2012; Gandolfi, 2021; Nakata, 2007). The last two decades have also seen attempts

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to braid Western centric science curriculum with Indigenous Science Knowledge (Baynes, 2015; Green, 2008).

Curriculum is a complex concept as it covers a range of practices, influences and issues across different levels of education. On the one hand, curriculum is concerned with syllabi and standards and their enactment by educators, often covered by such ideas as the intended, enacted and experienced curriculum (Erickson & Shultz, 1992). As a result of the postmodern turn, however, curriculum is also seen to reflect 'what counts' as valid knowledge at a particular time (Bernstein, 1971) and as being political and ethical in that the question of what is valid knowledge will be answered differently and have different consequences for different learners (Beyer & Apple, 1998; Wahlstrom, 2018). Trends and movements in curriculum often reflect the values of the time and who has power and influence over the curriculum.

Such issues of power and control are discussed at length in journals devoted entirely to the curriculum. Deng (2025, p. 6), for example, recently noted Bernstein's (1971, 2000) view 'that the primary function of schooling is to control access to knowledge and that the curriculum, through its structures and forms of knowledge, regulates, differentiates, and mediates access to knowledge among diverse social groups'. Deng describes the project of 'bringing knowledge back in', which partly reflects a recent shift away from competences as a core of the curriculum toward knowledge. However, he also notes that discussions of the curriculum often ignore the European notions of *Pädagogik* and *Didaktik*. These notions capture the practical process of education and those that educate. That is, how people translate content for the purpose of teaching. Deng's concern is that while it is important to focus on curriculum, there is also risk in separating curriculum out from the practice of education. Our point here is that there is much more to understanding curriculum than we might think, and that this special issue must be read in conjunction with papers in curriculum journals.

Science curricula across the world have been reformed to respond to social changes, underpinned by differing values and ideologies. For example, science education reforms in East Asian regions and jurisdictions such as China, Taiwan, Hong Kong, South Korea and Vietnam have evolved under the lasting influence of Confucian philosophy (Martin et al., 2014; Zhang & Wan, 2017) whereas both in the East and the West, the economic imperative has often driven science curriculum reforms (Coll & Taylor, 2012). It is still the case that many educators feel that the science curriculum does not appropriately reflect the needs of their students and society in general. Indeed, many Western curricula have been imposed on developing countries (Coll & Taylor, 2012) without consideration of the needs of the local context and have subsequently failed to deliver positive educational and social change. In recent years, growing awareness of anthropogenic climate change has led to student-driven calls for more effective education for sustainability and climate justice (BERA, 2021; Oxfam/UK Student Climate Network, 2019).

Considering these new challenges, the purpose of science education and the extent to which traditional curricula need to be protected, reframed or overturned requires urgent consideration. Curriculum theory, sociology, philosophy and psychology continue to provide important insights and critiques of these tensions, but how these translate into the science curriculum has received less attention. Careful reflection on past and recent curriculum reforms and their successes, limitations and failures needs critical interrogation as we have much to learn from what has come before as an important contribution for considering the future. Solid empirical research and critical engagement with theory are needed in order to broach the big question of what a science curriculum should encompass (Deng, 2018).

The 25th anniversary of the *Beyond 2000* report and our recognition of the ever-changing landscape in terms of what is important for science curricula internationally were the inspiration for this special issue. In it, we seek to illuminate current issues and future trends in the light of recent and urgent events and we hope that the papers contribute to this important discussion in many different ways.

The individual papers and their contributions

Reflecting the complexity and range of topics that studies of the science curriculum encompass, this special issue includes twelve contributions that take a number of perspectives. Broadly speaking, this issue includes papers that address justice and equity and the role of community and action, consider recurring issues within science education and curriculum and examine responses to new emerging challenges.

Justice and equity

Equity and social justice have emerged in recent years as a key approach and goal of the science curriculum (National Academies of Science, Engineering and Medicine, 2022). Grant Cooper, Al Fricker and Annette Gough (2025) provide a critical examination of First Nations perspectives in the newly-revised Australian Science Curriculum. The authors argue that the curriculum continues to marginalise and overlook the rich scientific contributions of First Nations communities. The authors posit a transformative and locally relevant curriculum which would be co-constructed with First Nations communities thus repositioning their perspectives in the curriculum using a science capital framing.

Sara Tolbert, Rosemary Hipkins, Bronwen Cowie and Pauline Wiati (2025) explore the relationship between the school science curriculum, Indigenous Knowledge and epistemic agency. Based on their experience as curriculum advisors for the Aotearoa New Zealand national curriculum, the authors share how they arrived at a multiple knowledge systems approach. The importance of teachers and schools having freedom to design curriculum that brings together multiple knowledge systems that is local and supports students is highlighted as important.

Thomas Delahunty (2025) presents a decolonial consideration of recent curricular discourses in science. He argues that while science has contributed significantly to humanity and forms a key pillar of social policy governance, the progress and innovation attributed to scientific education, within the broader STEM agenda, must be read against the rise in societal inequalities wrought by far-right hostilities and the general erosion of democratic principles in the milieu of neoliberal policy making.

Monica Sircar, Tashi Langton and Travor Kagochi's (2025) case study explores the interface of equity and curriculum by looking at how two biology teachers collaborated to develop curriculum materials that focus on equity and justice. They unpack the potential of teacher teams in developing curricula that build students' content knowledge, sense of relevance, and ability to use science to address injustice.

In their paper, Helen Gourlay and Tamjid Mujtaba (2025) explore the impact of curriculum, pedagogy and assessment on girls' uptake of post-compulsory physics. Through a review of curriculum and assessment in England from the 1980s on, this research shows that, although there has been much change over this period, there has been little change in girls' participation in physics. They explore the effectiveness of curriculum change on participation patterns and propose reform for policy makers, schools and teachers.

Recognising that school systems are enmeshed in tightly-woven networks of living, non-living and symbolic actants collaborating to maximise elites' profits while compromising the wellbeing of most other (a)biotic things, Larry Bencze (2025) offers some cause for hope by describing a science/STEM education framework that aims to help develop cultures of 'critical altruism' promoting 'ecojustice'. The initiative prioritises direct instruction about the problematic relationships among fields of STEM and societies and environments.

New challenges

Troy Sadler, Zhen Xu and David Fortus (2025) argue that Grand Challenges, which are 'complex, global, and multifaceted science and societal problems such as climate change, viral pandemics, loss of biodiversity, and quests for new energy sources' should be a prominent feature of the science curriculum. Restructuring around Grand Challenges would, they argue, challenge the positioning of canonical scientific concepts as the central organising feature of the curriculum. The authors introduce design principles which, they assert, are culturally responsive, practice oriented, attentive to student voice, and coherent within and across units. Such a curriculum, they claim, would create natural avenues for students to learn science, develop an interest in the subject, and build media and information literacy skills to become informed agents of change.

Xavier Fazio and Todd Campbell (2025) consider how the science curriculum should address socio-scientific issues (SSI) facing society in the light of the Anthropocene in a way that responds to the local needs of schools and communities. Systems thinking reveals the complexity of curriculum making in science across two schools that engage with SSI in their community. The authors propose the use of this theorisation to help teachers and researchers to more productively respond to the need for the curriculum to include reference to the Anthropocene.

Jonathan Osborne (who co-authored *Beyond 2000)* and Douglas Allchin (2025) respond to the concern over recent years about misinformation and how people engage with science material as citizens, particularly in the face of significant challenges. In their paper, they utilise the concept of the 'competent outsider' to consider what science education needs to include in order for students to be able to make judgements of whether a source is credible. They argue the need for standards that offer an understanding of the foundations of epistemic trust in science and convey how reliable knowledge is produced by diverse groups of scientists.

Responsive and community-driven curriculum

In the context of primary science education, Melinda Kirk and Joseph Ferguson (2025) report on an empirical study involving design-based research with Year 6 (aged 10-11) students. The authors propose an empirically informed framing of impactful inquiry including a focus on relevant-contextually integrated and responsive and actioned-driving science-informed change in the community.

Chris Speldewinde, Cristina Guarrella and Coral Campbell (2025), through an ethnographic study, describe how they implemented an emergent science curriculum in Australian 'bush kinders', where children aged 4–5 years-old engage in nature-based learning. They conceptualise an emergent curriculum as a spontaneous process that attends to young children's everyday lives and is supported by intentional teaching from educators. Through this example, they highlight the need for a curriculum that is flexible and responsive to children's discoveries, which is identified by educators as learning takes place.

Robin Millar (2025), the other author of *Beyond 2000*, reflects on the most explicit effort to act on the report's recommendations, the Twenty First Century Science project. He notes that despite evidence of success, external influences have steadily diminished its initial impact. According to Millar, the science curriculum has returned to its late twentieth century emphasis:

> 'Yet the Beyond 2000 critique remains as valid today as twenty-five years ago. The science curriculum in most countries does not reflect a clear vision of the contribution of science to a general education. The practical response to Beyond 2000 suggests that significant change requires clarity on intended outcomes and how they might be assessed, and the building of professional and social consensus around them.'

So, in concluding, we might feel that we are back to square one and that we are facing the same challenges that we were in the late 1990s. While the core aims of the science curriculum proposed a quarter-century ago remain valid and relevant, science education has since expanded to encompass broader social and educational goals and the field has also progressed in the ways it is trying to grapple with them. This evolution has been driven by a rapidly growing body of theoretical and empirical research, some of which is showcased in the contributions to this issue. This issue highlights both the complexity and range of curriculum work currently being undertaken in science education and the efforts of scholars to progress the field. Importantly, this special issue brings back into focus the need for continued work in this space.

We hope that this issue serves as a collective reflection for the international science education community on the evolution of science curriculum, offering insights that can inform future reforms at local and international levels. Certainly, there is much still to be done and the challenges facing young people and those who educate them are as great – if not greater – than they were back then. Our job as scholars and researchers is to provide critical insight and realistic hope – no more, no less.

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