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Bridging Theory and Practice in Technology Education: Supporting Student Agency Through Pedagogical and Values-led Frameworks

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Abstract

Bridging theory and practice in Technology education remains a challenge for many educators in primary and secondary contexts. While theoretical models offer valuable insights, classroom application requires careful consideration. This article explores how key philosophical and pedagogical frameworks, including Constructionism, Social Constructivism and values-led approaches foregrounding ethics, sustainability, and critical thinking, inform hands-on teaching that supports creativity, problem-solving, and meaningful engagement with technology.

Focusing on project- and inquiry-based learning, we synthesise literature showing how these approaches promote authentic, student-centred engagement. We also consider the contribution of Indigenous technological knowledge systems, illustrating how culturally grounded perspectives sustain community-driven design and enrich ethical practice.

These perspectives have important implications for teachers and students. In contemporary Technology education, educators must move beyond 'telling' to facilitating Design thinking, problem-solving, and critical inquiry, guiding students to engage in hands-on, iterative learning. Students take on a more active role, constructing knowledge through experimentation, collaboration, and reflective practice. By shifting from passive recipients to innovators and ethical decision-makers, students develop skills in technology use, critical thinking, creativity and adaptability.

Technology education therefore equips students with both technical knowledge and the agency to situate it within broader ethical and cultural contexts, preparing them to shape sustainable technological futures.

Keywords

Technology education; student agency; Indigenous knowledge systems; ethical technological literacy; Design thinking

Bridging Theory and Practice in Technology Education: Supporting Student Agency Through Pedagogical and Values-led Frameworks

Technology education empowers students to think critically, act ethically, and create with purpose. Through hands-on making, design thinking, and inquiry, students engage with real-world challenges and construct knowledge through authentic projects (Albion et al., 2018; Buckley, 2023). Yet, translating diverse theoretical frameworks into practical classroom approaches remains complex (McLain, 2022). Terminology varies internationally; we use ‘Technology education’ as an umbrella term for school subjects concerned with designing, making and computing, such as the United Kingdom’s Design and Technology, New Zealand’s Technology, and Australia’s Design and Technologies and Digital Technologies.

To better understand the pedagogical imperatives of contemporary Technology education, it is essential to consider its historical and theoretical underpinnings. The origins of Technology education lie in “various forms of manual education” (Gill, 2023, p. 9), with its history as a curriculum area in schools predating the 1800s (Jones et al., 2013). These early forms of manual education often emphasised technical proficiency, repetition, and tangible production, reflecting societal values that prioritised vocational skills and craftsmanship. Since then, Technology education has become part of compulsory education globally (Jones, et al., 2013), evolving in response to shifting social and political values. Contemporary approaches now involve students in ethical reasoning, and creative problem-solving, positioning them not only as makers but as critical thinkers and responsible innovators.

Reflecting these curriculum shifts, Buckley (2023) describes a movement away from Behaviourist pedagogies adopted for technical and craft-oriented courses, to Cognitivist, Constructionist, Constructivist, and Social Constructivist approaches. These frameworks require higher-level cognitive processes and broader learning outcomes. Importantly, they offer distinct perspectives on knowledge, learning, and development (Jones et al., 2013) and provide educators with pedagogical models that support creativity, collaboration, inquiry, and ethical reflection.

To understand how these pedagogical approaches have emerged and what they offer, it is helpful to explore the theoretical traditions and philosophical shifts that underpin contemporary practice in Technology education. These theoretical perspectives offer more than background; they actively inform and guide educators’ teaching practices (Jones et al., 2013). Examining theory provides this guidance via implications for pedagogical practice that arise from epistemological and philosophical positioning, and as such it can help to avoid pitfalls such as basing pedagogical practice on oversimplifications of a given perspective.

Taking Constructionism as an example, there is the potential for pedagogical practice to be built on its characterisation as ‘learning by making’, yet, as Papert (1991) advises, it is “much richer and more multifaceted, and very much deeper in its implications, than could be conveyed by any such formula” (p. 1). Learning involves the reconstruction of knowledge through hands-on experiences in which students construct “something that they believe in” and the mandate of Constructionism is to overcome barriers for diverse groups through the inclusion of social and affective dimensions of the content area (Papert, 1986, p. 9). Kafai and Resnick (2011) develop this further, explaining that by having students work on “personally meaningful activities and projects” (p. 2), Constructionism harnesses affect to maximise intellectual engagement, and students’ creation of their own ideas.

Similarly, misunderstandings of Social Constructivism can limit its value. These may include seeing implementation of Social Constructivism as simply a matter of employing group and collaborative teaching and learning strategies. Vygotskian socio-cultural theory (1978) contains numerous key principles that need to be understood. One of these key principles is that learning and development are interdependent and mediated social processes. This relationship matters because appropriately designed learning precedes cognitive development that triggers a range of developmental processes. Of importance and relevance to Technology education, "in the process of cultural development, intellect, thinking, invention, and discovery, in the true sense of the word, play an enormous role" (Vygotsky, 1997, p. 94).

Table 1 provides a summary of selected key attributes of learning theories and their applications in Technology education, as discussed above.

Table 1:
Theoretical Frameworks and Learning Theories in Education

Learning theory/ framework	Pedagogical techniques and practices	Description	Application and examples in Technology education
Instructivism (circa 1965) Key people: Robert Gagne	• Direct instruction • Lecture-style teaching • Demonstrations • Use of standard textbooks • Structured curriculum delivery	Instructivism is a traditional learning theory where knowledge is transmitted from educator to student through direct instruction. The focus is on structured curriculum delivery, emphasising memorisation and the acquisition of specific skills.	Students could engage in direct instruction tasks, such as following step-by-step instructions in a learning module or video to build a circuit or designing a 3D model using CAD software.
Constructionism (circa 1980) Key people: Seymour Papert	• Active learning • Problem-solving tasks • Hands-on learning • Group work • Investigative activities	Constructionism, derived from Constructivism, emphasises learning through hands-on creation and construction of tangible artefacts. Students actively engage in the design and fabrication process, promoting deeper understanding and retention of concepts.	Students could engage in hands-on, project-based learning by designing and physically creating products like 3D-printed objects, apps, or functioning robots. By working through the process of building tangible artefacts, students deepen their understanding of technical concepts and reflect on their creations to improve and iterate.
Social Constructivism (circa 1956) Key people: Lev Vygotsky	• Fostering dialogue and cooperation • Group projects • Discussions • Collaborative problem-solving tasks • Guidance and mediation	Social Constructivism emphasises knowledge construction through social interaction and collaboration. Students actively engage with others to create meaning and understanding from shared experiences.	Students could work collaboratively in groups to design and build a robotic system or a smart city model, with each team member contributing their unique perspective and knowledge. Through peer interactions and discussions, they would co-construct understanding of how technology works and how it can be used to solve problems. Students might also share their progress with other groups, allowing for cross-group learning and feedback.

Note. Adapted from Mason et al. (2025, pp. 20–21).

Pedagogy within Technology education facilitates student engagement "with their technological world to better understand the nature of the technologies and their accompanying design and research practices" (Wells & Van de Velde, 2020, p. 221). Its features commonly include an experiential, real-world orientation (after Dewey); authenticity; design thinking driven by a societal need, question, or problem (Stables, 2020); an integrative approach (Wells & Van de Velde, 2020); and consideration of cultural context and social interactions (Williams, 2016).

Such complex goals require appropriate pedagogical models. McLain (2022) identifies Project-based Learning as a signature pedagogy for Technology education, while Wells and Van de Velde (2020) suggest some specific affordances of design-based learning that make it especially suitable. To support educator decision-making, McLain (2022) suggests considering questions relating to the surface, deep, and implicit structures of courses, helping address varied emphases, such as designing and making across Technology education.

Having explored the theoretical foundations and pedagogical shifts shaping contemporary Technology education, the next section considers how these changes are transforming the roles of educators and students.

Reimagining the Role of the Educator: From 'Telling' to Facilitating

In contemporary classrooms, the role of the educator shifts from content-delivery to designer of learning experiences. This transformation aligns with Constructivist and socio-cultural learning theories (Dewey, 1938; Vygotsky, 1978), which position students as active participants in constructing knowledge through contextually rich and collaborative activities. With this change in focus, educators no longer merely 'tell' or deliver static content; they actively demonstrate, co-create, and engage with their students in the process of making, testing, and refining. They facilitate inquiry, support iteration, and model critical and creative engagement, not only through discussion, but explicitly by 'doing'. While traditional Technology education emphasised 'showing and doing', the shift we describe here extends this orientation by positioning the educator less as a transmitter of knowledge and more as a facilitator of inquiry, design, and meaning making.

Project-based learning and Design thinking provide pedagogical frameworks that position digital technologies both as tools for learning and as contexts for disciplinary exploration. Educators who use these approaches design learning environments where students create solutions to real-world problems, thereby applying knowledge across disciplinary boundaries (Bell, 2010; Cope et al., 2022). Through this approach Technology becomes both a tool for thinking and learning (AITSL, 2024), not just 'doing'. For example, a primary educator might scaffold a Project-based learning task using Scratch on iPads to create an animated retelling of *The Very Hungry Caterpillar* (Carle, 1969), integrating science content (life cycles), English (narrative structures), and digital literacy. In this scenario, the digital technology supports not just skills acquisition, but also creativity, problem-solving, and multimodal expression that reflects both students' understanding and their process.

The TPACK (Technological Pedagogical and Content Knowledge) framework (Mishra & Koehler, 2006; Petko et al., 2025) offers a useful structure for understanding the intersection of disciplinary knowledge, digital technology, and effective pedagogy. It supports educators in making purposeful decisions about how and when to use digital technologies in ways that genuinely enhance student learning and agency. TPACK also helps teachers bridge theory and practice, guiding the selection of pedagogical approaches that align with both disciplinary goals and student needs. For example, designing a watering system for a school garden or designing a garden to host plants to support endangered species using 3D design software, such as Minecraft, CAD programs or Google SketchUp. This hands-on process of creating tangible solutions through iterative design is consistent with Constructionist approaches, where students build understanding through personally meaningful projects (Papert, 1991). Doing so not only enhances relevance but also supports culturally responsive pedagogies (Ladson-Billings, 1995).

Technology educators enable students to be creators, not just users, of technology. This includes supporting iterative learning through prototyping, peer feedback, and critical reflection (Hattie & Timperley, 2007), modelling ethical decision-making, and prompting students to consider consequences of technological design. These practices develop core capabilities such as collaboration, adaptability, and ethical reasoning (Trilling & Fadel, 2009). These collaborative, scaffolded experiences reflect Social Constructivist principles in which learning is socially mediated and developmentally scaffolded (Vygotsky, 1978). Importantly, such environments foster agency: students learn *how* to learn and *why* knowledge matters. In design, development of students' knowledge and agency is interconnected (Stables, 2008) and includes opportunities to empower students by actively co-constructing knowledge, enabling students to gain confidence and a deep understanding of themselves as students (Kavousi, et al., 2020). Meaningful learning opportunities that respond to real-world design problems aligned with issues that matter to students (Hill, 1998) enable them to take initiative in their learning, creating a sense of purpose through motivation and engagement (Barak, 2010), and apply their knowledge both creatively (Stables, 2013) and critically (Keirl, 2020), whilst developing 'design agency' (Lehtonen, et al., 2022) alongside design 'competencies' (Rusmann & Ejsing-Duun, 2022) and critical dispositions (von Mengersen, 2017).

Effective facilitation also involves designing open-ended tasks that encourage divergent thinking and supporting students to take intellectual risks (Resnick, 2017). Educators model critical questioning, e.g., "Whose perspective is missing in this design?" and encourage creative experimentation. As students grapple with real-world challenges, they build metacognitive skills and deepen their understanding of disciplinary content.

Ultimately, reimagining the roles of educators in Technology classrooms necessitates a paradigm shift: from teacher-centred instruction to the co-construction of learning (from telling to facilitating). This shift becomes even more imperative within an AI-enabled digital environment where students and educators also collaborate with machines (Huang et al., 2023). By embracing contextual, iterative, and student-driven pedagogical designs, educators move beyond knowledge acquisition and develop future-focused thinkers with the capacity to act ethically and creatively in a rapidly changing world.

Ethics and technology

Ethical reasoning (ACARA, 2022) is an important aspect of conceptualising, developing and producing designed products in Design and Technology educational contexts. Keirl refers to this as 'ethical technological literacy' (2011, p. 235), where students are encouraged to develop ethical attitudes and values in their relationship with technologies in design-based pedagogies. Students critique the role of technology in society, consider its positive and negative impacts, and ask critical questions about what, why and how products are made and used and for whose benefit (de Vries, 2016; Keirl, 2020; Petrina, 2017).

Students explore intended and unintended consequences of design decisions, especially in relation to environmental stewardship and social justice (von Mengersen & Wilkinson, 2020). This aligns with a value-sensitive approach to design, where ethics are embedded throughout the process (Stables, 2015). Human-centred design, for example, foregrounds the principle that "products and services should meet people's needs and aspirations" (van der Bijl-Brouwer & Dorst, 2017, p. 1), promoting empathy, accessibility, and equity. This ethical framing aligns with several United Nations Sustainable Development Goals (United Nations, 2015): SDG12: Responsible Consumption and Production; SD9: Industry, Innovation and Infrastructure; SDG4 Quality Education; SDG11: Sustainable Cities and Communities; SDG13: Climate Action and SDG10: Reduced Inequalities.

Globally, education policy now emphasises student agency in shaping preferred futures that consider both individual and collective wellbeing. The OECD's (n.d.) Learning Compass 2030 highlights that "students need support in developing not only knowledge and skills but also attitudes and values that can guide them towards ethical and responsible actions".

Authentic, values-led Design thinking processes begin with empathy, that is, a thoughtful consideration of the users' needs and the context in which the design will be used. Tools like the 'Design Value

Framework' (Design Council, 2025) support this process. Students engage in ethical product design by using empathy mapping, considering user needs, and applying principles such as accessibility, equity, and social justice.

Ethical reasoning also involves speculative Design thinking and legal and regulatory responsibilities, including work health and safety, intellectual property, and international (International Organization for Standardization, 2025) or local standards (Standards Australia, 2018). It is considered a *designerly* ability (Buckley, 2023) developed conceptually by questioning values, intent and responsibility, and practically through selecting appropriate technologies, including materials, tools and processes. For example, a student might ask, 'Could a switch to biodegradable materials or a design for durability approach reduce impact?'

Consequently, a pedagogy of critique has evolved as a dimension of Design and Technology education. As Keirl (2020) explains,

> the praxis of critiquing embraces a lexicon of related terms such a critique (as noun and verb), criticism, critical reflection, critical thinking, imagination and interpretation. To these can be added critical stance, critical distance, critical disposition, scepticism, empathy and ambiguity. (p. 137)

He also suggests that critiquing involves regular dialogue, to foster discussion in classroom environments and debate the values of users, technologies, processes and designed products observing that when critique becomes a regular practice, it helps uncover underlying values, making them open to questioning and reassessment. This ethical scrutiny should be applied across all design phases, from ideation and production to use and end-of-life (Keirl, 2009).

Design approaches grounded in 'user-centred design' begin with empathy and iterate through user-informed stages (Interaction Design Foundation, 2016). Several well-established Design thinking models place 'Empathy' as the first 'step' in any design process. IDEO's Human-Centred design model places 'Empathy' at the centre of its 'Inspiration' phase, where designers immerse themselves in users' lives (IDEO, 2018). In the UK Design Council's Double Diamond Model, the 'Discover' phase aligns with empathetic engagement to identify real user needs (UK Design Council, 2021). Similarly, the Stanford school Design Thinking Process Diagram (Dam, 2025) begins with 'Empathise – understand users and their needs through observation and engagement', followed by Define-Ideate-Prototype and Test. In this model 'Empathy' is foundational, enabling designers to deeply understand the users' experiences, emotions and perspectives.

In contexts like textile design, students integrate ethical thinking by considering sustainability, fair labour, and consumer impact in design and production decisions (Valentine et al., 2017). This includes using sustainable materials, minimising waste, and addressing environmental impacts in all phases (before, during and after product use) (Fletcher, 2013), acknowledgement of fair labour practices (Vijeyarasa & Liu, 2022) and consumer behaviour and values. Design-for-sustainability strategies include using renewable materials, reducing waste, upcycling, and designing for repair or durability (Fletcher, 2013; Fletcher & Grose, 2012). Taken together, these approaches directly respond to the ethical problems of fast fashion and foreground a values-driven orientation in textile and fashion education (Harvey & Ankiewicz, 2023).

A practical example is when students are asked to analyse an existing product and redesign it with a focus on improving sustainability, such as a sports bag or timber utility box. This multifaceted design task requires students to critically evaluate the original product by analysing its attributes using established product design factors, which include both 'soft' attributes (such as user appeal, value, and aesthetics) and 'hard' attributes (such as materials, function, and manufacturing processes). This analysis phase, often termed *product decomposition*, helps students deconstruct and understand a product's composition and performance in context.

Sustainability is primarily a soft attribute as it reflects values, ethics, and broader impacts – such as environmental responsibility, social equity, and long-term usability. These are often described as 'soft' attributes because they are subjective and based on user or societal expectations. However, evaluating sustainability requires consideration of both soft and hard attributes in specific contexts. For example, to assess how sustainable a product is, students are encouraged to conduct a Life Cycle Assessment. This involves examining measurable, technical criteria—such as energy efficiency, material lifecycle, recyclability, and compliance with environmental standards—across the product's entire life cycle, from design and manufacture to use and eventual disposal. This research process then informs the redesign of the product using a sustainable design strategy like design for disassembly, or design for durability (Acaroglu, 2022). The first aspect a student will usually focus on is the materials used in the existing product e.g., a *textile* sports bag or a *timber* utility box. Asking effective questions is essential to exploring design, applied ethics, and sustainability. Explorations in how to embed ethics in design education (Findeli, 2001) have been undertaken by researchers in Engineering (Hamad et al., 2013; Martin et al., 2021) and are evolving in the broader sphere of Technology education, described by Keirl, as 'ethical technological literacy' (2006). In sustainability-focused redesign, materials are the student's first point of consideration, as they play a critical role in the product's overall environmental and ethical impact (von Mengersen & Wilkinson, 2020). Therefore, a set of ethical questions to guide a student redesigning a sports bag with a focus on practical sustainability could include material choices, manufacturing and labour, durability and longevity, end-of-life considerations, user and community impact, environmental impact, and social responsibility. Examples of questions related to:

- *Material choices* – What materials have been used, and are they sustainably sourced or recycled?
- *Manufacturing and labour* – Where and how has the bag been manufactured? Were fair labour practices followed?
- *Durability and Longevity* – How durable is the design? Can it be easily repaired or maintained instead of replaced?
- *End of Life considerations* – What happens to the bag at end-of-life? Is it designed for disassembly and recycling, or will it end up in landfill?
- *User and Community Impact* –Who is the intended user, and how does the design support their health, safety, and accessibility? Does the design meet the needs of diverse users, including those with physical limitations?
- *Environmental Impact* – What is the carbon footprint of this bag across its life cycle? How much energy, water, and waste are involved in its production and disposal?
- *Social Responsibility* – Am I promoting a culture of overconsumption, or encouraging mindful, sustainable use? Does the bag design promote ethical branding or misleading 'greenwashing' claims?

For a timber utility box project, students could consider whether to use new materials or recycled materials, weighing environmental impacts, local economic factors, and processing costs through a Consequentialist ethical lens. This perspective asks whether the end results of the decision, such as using recycled timber, justifies how the materials are sourced and processed. To make an informed decision, students could weigh up and consider the relative good in both options. Key questions might include: What are benefits of recycling timber to divert it from landfill? What are the costs and risks of processing and transporting recycled timber? How do local economies benefit from producing and purchasing new timber (e.g., local jobs for forestry, transport, production, retailing)? What are the environmental impacts of deforestation, timber harvesting, and processing? What is the overall environmental toll when considering the full life cycle of both recycled and new timber?

Engaging students with ethical technological literacy in design works best when approached through curiosity, empowerment, and real-world relevance (Stables, 2015), rather than guilt. In Technology education contexts, this can be done by framing ethics as a design opportunity where ethical challenges become design constraints that require innovative thinking – e.g., asking how we might create a product that's both functional and fair to people, and the planet. Emphasising impact over blame by focussing on how students design choices can influence new outcomes – e.g., identifying the current limitations of this product, and design opportunities. Design case studies in the classroom provide inspirational stories of ethical and sustainable design and promote aspirational thinking and agency. Introducing ethics as a set of practical tools that designers use – e.g., teaching ethical frameworks (like life cycle analysis and empathy mapping) as tools for making informed decisions. Encouraging students to connect with real users in their local communities helps them see ethics as relational and practical, not abstract or moralising. Normalising ethical reflection using small regular prompts at all stages of the design process – such as “Who might be excluded by this design?” Or “What happens to the product at the end of its life?” – supports deeper student engagement with creativity, agency and practical Design thinking.

Embedding ethics into design is a multifaceted process that involves considering social, environmental, and economic impacts, user needs, cultural contexts, and long-term consequences at every stage of the design process. The concept of Intersectionality offers a transformative framework for shaping the future of design education (St John & Suhendra, 2024) by highlighting how overlapping social, cultural, and environmental factors influence ethical and sustainable design practices. Intersectionality encourages students to consider diverse perspectives and systemic inequalities, promoting more inclusive, responsible, and context-sensitive design solutions. This approach helps students develop empathy, critical thinking and ethical responsibility. As a result, students develop a stronger sense of agency, realising their design choices can challenge systemic inequities and create more inclusive, sustainable futures (Stables, 2015). Building on the importance of ethics and sustainability in design practice, the integration of Indigenous Knowledge systems offers further opportunities to enrich Technology education.

Indigenous Technologies

Educators are working towards integration of Indigenous technologies knowledge into Technology education internationally. Kimbell (2005) described Indigenous technologies as deeply contextualised practical knowledge and know-how which was central to survival, “and is passed down from generation to generation through an oral and experiential tradition” (p. 1). Examples of nations who have embedded Indigenous technologies knowledge in their curricula include New Zealand, Canada and South Africa (Gumbo & Williams, 2024; Seleke et al., 2025). Other countries, including Australia, are in the process of doing so, resulting in consideration of approaches and evolving discussions about ethical integration of Australian First Nations Aboriginal and Torres Strait Islander Indigenous histories, cultures and knowledges into Technology education. This content has been included in the Australian National Curriculum (ACARA, 2018) since 2010 as one of three Cross-Curriculum Priorities to integrate Indigenous perspectives across the curriculum, in the eight discipline areas.

However, despite Australian educators now having a professional obligation “to incorporate Indigenous perspectives in their teaching [they] face challenges due to the Western-centric priorities in schools” (Riley et al., 2024, p. 1), and broadly lack confidence and feel underprepared (Hogarth, 2022; Rogers, 2018). Researchers have observed that educators are fearful or nervous about teaching content from which they feel epistemically and cognitively disconnected (Lowe & Galstaun, 2020; Thompson et al., 2024). The Australian Educators’ Survey in 2023 “found that over half (51 per cent) of educators aged 35 years and over felt unprepared to deal with First Nations histories and culture and student diversity” (Hogarth, 2024, para 5). Researchers describe the ethical challenges for educators trying to embed authentic Indigenous cross-curriculum content (Lowe & Galstaun, 2020) and the need for First Nations pedagogical narratives (Weuffen et al., 2024). Collectively they outline the need for knowledge-and-ethics to inform curriculum values (Zipin & Brennan, 2020).

In some international curricula, for example Canada, Indigenous knowledge is linked to environmental stewardship and conservation-based ethics (Beckford et al., 2010), and related SDGs (13, 14, & 15). Another approach well-linked to Design thinking is how “inclusive design-indigenous storytelling as codesign” (Barcham, 2023, p. 1) can be used as a user-centred, ethically-informed methodology.

Gumbo (2022) suggests that embracing Indigenous design and technological knowledge provides inclusivity for Indigenous students by creating a “Design and Technology classroom environment that facilitates awareness and appreciation for students with diverse cultural backgrounds which is related to their racial, or ethnic, language, socio-economic, gender and sexual orientation” (p. 195). In countries including New Zealand, local contextualisation of language and knowledge remains a challenge: “the relationship between the role of a national curriculum and localised curriculum, in particular place-based Indigenous knowledge” (Lemon et al., 2023, p. 169) can be hard to meet.

Recent studies have outlined practical solutions in which educators are being encouraged to refer to frameworks, guidelines and examples and to reach out to local Indigenous community members for guidance. Examples of frameworks and guidelines include the first Indigenous-led guidelines on knowledge CSIRO (2020) and Indigenous Australian STEM in K-12 classrooms (Khan & Johnson, 2021). Three guiding principles have been identified by Hogarth (2024): 1. Recognise Indigenous Cultural and Intellectual Property (ICIP); 2. Reparative Justice – acknowledge and address past injustices and understand how they persist in people's lives; and 3. Relationality – the idea that everything is connected is intrinsic to Indigenous ways of being, knowing and doing.

Table 2 aligns Hogarth's three guiding principles (2022) with specific practices in technology education.

Table 2:
Guiding Principles and Practices as Aligned to Technology Education

Guiding principle	Practices and examples
Recognise Indigenous Cultural and Intellectual Property (ICIP)	Embedding accurate historical knowledge (Weuffen, 2019) Honouring Indigenous cultures (Akama et al., 2019; Seemann, 2015) Recognising Indigenous technologies (Ajani et al., 2024; Gumbo, 2014) Incorporating Indigenous languages (Gumbo & Williams, 2024)
Reparative Justice	Critical reflection on systems (Weuffen, 2019) Challenging stereotypes (Weuffen, 2019) Supporting Indigenous-defined priorities (St John & Edwards-Vandenhoek, 2022) Empowering identity and leadership (Gumbo, 2022; Trinick & Heaton, 2021)
Relationality	Engaging with Elders and Knowledge Holders (Anderson et al., 2024) Collaborative design respecting cultural protocols (Anderson et al., 2024) Holistic learning models (Akama et al., 2019) Land and place-based learning (Davidson-Hunt et al., 2012)

Introducing students to ethics through ICIP (Arts Law Centre of Australia, n.d.) is an effective way to ground ethical concepts in design education contexts because local "indigenous knowledge reflects a community's history, cultural and social identity, and its values" (IP Australia, n.d.). Indigenous IP brings abstract ethical principles (like fairness, respect, and responsibility) into tangible, often complex real-life situations: requiring students to ask questions like: Who owns traditional knowledge or cultural expressions? Is it ethical for a company to use Indigenous designs for profit without consent? What does consent look like in collective, rather than individual, knowledge systems? It also prompts students to critically examine assumptions embedded in dominant legal and ethical systems e.g., how Western IP often prioritises individual ownership, while many Indigenous Knowledge systems are communal and intergenerational. The contrast between these approaches allows students to question the universality of mainstream ethical and legal frameworks. Consideration of Indigenous IP can also help students understand the value and sacredness of certain cultural expressions (Seemann, 2015) helping to build empathy and respect.

Ethics, law, culture, and sustainability all intersect in ICIP, necessitating interdisciplinary discussions in Technology education that draw from Social Studies, Art, Law, Science, and environmental stewardship (Moalosi et al., 2023; Seemann, 2015). These discussions illustrate how ethical thinking permeates all areas of life, highlights power imbalances and historical injustices. Engaging with ethics through ICIP protocols (National Library of Australia, n.d.) encourages students to think about restitution, equity, and reconciliation and understand ethical responsibility in a broader social justice context. By grounding ethical learning in ICIP, students don't just learn *about* ethics — they practise ethical thinking, consider multiple cultural perspectives, and begin to understand their own power to act in thoughtful and respectful ways. This cultivates a deeper sense of student agency — not only as students, but as ethical actors in the world (Crawford, 2021; Stables, 2015).

For example, a rural South Australian school used humanoid robots to support both Aboriginal and non-Aboriginal students in learning the Narungga language and computational thinking, strengthening cultural connection through technology (CSIRO, 2017). As students programmed the robots, they simultaneously developed coding skills and deepened their understanding of Narungga language and culture. The project also raised important ethical considerations about working with Indigenous Knowledge, for example, how to respectfully handle cultural data, and how Aboriginal and Torres Strait Islander perspectives can inform inclusive design in digital technologies, such as apps and games.

Embedding Indigenous Knowledges in Technology education highlights the importance of designing learning environments that encourage cultural responsiveness and critical reflection. These pedagogical considerations align with broader trends in Technology education, where promoting student agency is increasingly recognised as essential for preparing students to navigate complex, real-world challenges.

Supporting the development of student agency

The pedagogical approaches explored throughout this article, including design-focused, ethically grounded, and culturally responsive practices, provide strong foundations for developing student agency. Project-based and inquiry-driven learning, when informed by ethical reflection and diverse knowledge systems, enables students to engage critically with emerging technologies, develop resilience and adaptability, and imagine more inclusive, sustainable, and socially just technological futures.

We frame this work as developing ethical technological literacy, which equips learners to question purposes, power and practices; to weigh impacts on people, Country/Place and environments; and to make informed, values-led design decisions. In the Australian context, this includes foregrounding First Nations histories, cultures and knowledges, respecting relationality, stewardship and community benefit, and embedding these perspectives in design briefs, criteria and critique as organising principles.

Given the rapid rise of intelligent, data-rich, AI-enabled environments, supporting agency is both more critical and more complex. Students must now be equipped not only to learn technologies, but to question, adapt, and shape how they are used and in whose interests they serve.

Bridging theory and practice in this way requires educators to adopt a flexible, exploratory stance where they are co-constructing learning with students, valuing process as much as product, and embracing the uncertainties of an accelerating technological world. Through this approach, Technology education becomes not just about what students make, but about how they think, decide, and grow through the making.

Ultimately, when students are provided with agency, scaffolded support, and meaningful contexts, they respond with deep engagement, creativity, and outcomes that often exceed expectations (Albion et al., 2018; Bell, 2010; Resnick, 2017). Technology education continues to evolve as a transformative space – preparing young people to actively shape technological futures with insight, responsibility, and imagination.

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