

# TOWARDS UNDERSTANDING THE DEVELOPMENT OF 21ST CENTURY CAPABILITIES: A SCOPING REVIEW OF CRITICAL THINKING

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## Abstract

The learning and teaching of so-called general capabilities – including critical and creative thinking, problem solving, and ethical reasoning – is widely considered as problematic because of their detachment from a particular context of application. At the same time, an increasing employer demand across industries for such 21st century capabilities, specifically critical thinking, seemingly belies the lack of clarity around what is critical thinking and its relevance to a wide range of contexts, while articulating how it might develop and be assessed in distinct contexts. This begs the question: how might educators recognise, in generative ways, the learning and development of 21st century capabilities in their practice? This paper reports on a scoping review exploring the nature, application and influences of critical thinking in diverse professional and disciplinary practices. Key characteristics of critical thinking in action were distilled and are discussed here in relation to how they shape the design of resources and research probes that both support teachers and students in developing critical thinking in a range of contexts, and enable them to investigate how that development might be recognised, understood and tracked over time. Here, we explore the implications for developing critical thinking capabilities as applied in complex problem-solving situations. To do that, we contextualise our discussion within an innovative school-university research partnership designing transdisciplinary challenge projects to pilot how these 21st century capabilities can be developed and actioned for future practical contexts.

Keywords: Critical thinking, transdisciplinary education, 21st century capabilities, research-practice partnerships.

## 1 INTRODUCTION

Why has the development of general capabilities gained educational importance in recent years? In a review of the development of general capabilities in Australia, *Changing Priorities? The Role of General Capabilities in the Curriculum*, Weldon [1] identified factors that focussed attention on so-called 21st century skills, key competencies, graduate attributes, and the transferable, workplace, transversal and generic skills needed to prepare young people for work, employment and participation in society. General capabilities including, for example, critical and creative thinking, problem solving, ethical reasoning and intercultural understanding, have emerged in response to profound changes precipitated by advances in technology and automation, complex work, globalisation, and growth in multiculturalism as society moved into the 21st century. Associated with these changes was an urgent need to address new, multifarious social, economic and environmental problems [1]. The shift in educational focus towards programs for developing general capabilities [2], however, has raised questions about whether such skills are discrete, so they can be developed in educational settings, and also generalisable, so they can be applied in different situations.

Industry demand for employability skills suited for a future workforce, including analytical and “soft skills” (collaboration, creativity, teamwork, leadership) to enable adaptability and retention is well documented [3], [4], [5]. Results from an interview study of employers and CEOs about what they were looking for in employees identified seven key skills needed in a globalized era, including critical thinking and problem solving [6]. Other recent reports suggest industry-school partnerships as a mechanism to teach general capabilities, promoting real-world learning and developing enterprise skills coupled with specialty knowledge [7]. Arguably, educational programs that equip young people for dynamic careers in the future workforce are crucial. Despite their seeming importance, educators continue to face questions about implementing general capabilities in the curriculum, including assessing development and achievement. So, what is problematic about teaching these general capabilities? For Masters [8], the questions centred on the following questions: (1) Which general capabilities are prioritised and why? The Gonski review [2] suggested any selection from a wide range of possibilities be considered; (2) How are capabilities defined?; (3) How discrete are these capabilities? Are they best developed/assessed as part of problem-solving?; (4) Does the generalisability of capabilities imply they exist independently of

context, and how broad is this range?; and (5) How are capabilities best incorporated into a school curriculum, how are they best taught or developed, and how are they best assessed?

Recognizing the challenge general capabilities pose for education, an opportunity arose for a school-university partnership to tackle that challenge as a collaborative research and development project.

## **2 A SCHOOL-UNIVERSITY RESEARCH AND DEVELOPMENT PROJECT**

The *Gonski 2.0 Review* [2] recommended strategies to achieve general capabilities in Australian school contexts. For example, *Area 2. Equipping every student to grow and succeed in a changing world* recommended: introducing new reporting with a focus on learning attainment and learning gain; curriculum revision to present general capabilities as learning progressions; make acquisition of general capabilities more prominent; and strengthen community engagement to enrich learning [2].

The process of translating the complex challenge posed by the *Gonski Review* into school curricula raises questions as to the value of implementing its recommendations. The transdisciplinary research pilot project, *Understanding and Tracking the Learning of 21<sup>st</sup> Century Capabilities: A Pilot Study*, is a school-university partnership that aims to address that challenge by developing methods and processes for understanding general capabilities central to the success of innovative school initiatives providing different learning pathways. The pilot will take one general capability, critical thinking, and devise ways to meaningfully measure, track and report its development over time in diverse situations and learning experiences to stakeholders (students, teachers, parents, principals, CEPD leadership team, industry partners, employers). The project seeks to generate creative, research-informed professional learning and teaching resources to support exploring, probing and tracking the development of critical thinking. The project will test a novel methodology for supporting (professional) learning, and collaboratively generating educational knowledge in an innovative school-university partnership for transdisciplinary research and development. The project is framed by three questions: How might educators understand, in generative ways, the learning and development of a particular 21<sup>st</sup> century capability? How and why might the design of different educational experiences enable learners' development of the selected 21<sup>st</sup> century capability? How and why might (students and) educators measure, track and communicate the achievement and relevance of the selected 21<sup>st</sup> century capability to other stakeholders?

A scoping review of published literature was undertaken to gather definitions, examples and insights about critical thinking from sources such as professional practice, research, educational programs and strategic initiatives to inform the development of the learning and teaching resources.

## **3 METHODOLOGY: A SCOPING REVIEW**

Evidence-based education uses research evidence to inform decision-making in education policy and practice. A systematic, rigorous and transparent review of published literature is a secondary level of analysis that examines evidence in published studies and addresses concerns about contextual and methodological limitations, following an aggregative synthesis logic [9]. In contrast, reviews that follow a configurative logic [10] are more wide-ranging in scope and seek to build theory by investigating meanings and understandings of particular phenomena, and why specific audiences/contextes may be relevant. Scoping reviews are an example of the latter, used to map concepts underpinning a research field/topic, and clarify working definitions and/or its conceptual boundaries [11]. Scoping reviews do not generally report search strategies, inclusion and exclusion criteria, study quality assessment criteria [12], and instead, "describe the nature of a research field rather than synthesise findings" [9, p. 1].

The scoping review process reported in this paper broadly followed Hallinger [11]: articulate the research question/s and define review purpose and objectives; develop inclusion and exclusion criteria, determine source types and devise procedures for data extraction, analysis and synthesis; and outline a conceptual framing guiding selection, analysis and interpretation. Scoping reviews tend to use exploratory and methods that emerge iteratively throughout the review [10] for the purpose of "exploring how, by whom and for what purpose [this] particular term is used in a given field" [10]. The aim was to generate a conceptual map and offer a transdisciplinary interpretation of what is known about critical thinking and its component parts, its development and application in various educational contexts, and its contemporary importance to students, educators and employers. Specifically, we aimed to identify and distil conceptualisations of the term and source practical examples of strategies to enhance critical thinking development in diverse professional and disciplinary practices.

### 3.1 Research question and purpose, search terms and procedures

The research question framing the scoping review was: What is critical thinking? The outcomes of the review will be used in an innovative school-university research partnership designing transdisciplinary challenge projects to pilot how critical thinking, as one of a number of 21st century capabilities, can be developed and actioned in future practice contexts. Researchers independently conducted internet searches of the term “critical thinking” to scope how the term has been defined across disciplines, and educational and practice contexts. The search generated 1,090 million hits in *Google* and more than 4.5 million in *Google Scholar*, reflecting both the enormous interest in the concept, and the difficulty in framing it as a singularly focused area of scholarship; an ideal combination for transdisciplinary research. One researcher scanned titles and abstracts to iteratively identify conceptual, editorial and empirical studies and then conducted manual searches of reference lists to define inclusion and exclusion criteria as understanding of the published content became clearer.

Papers were included if they were published: internationally between 2010 and 2020; in English; in scholarly or professional journals; with full text availability; included ‘critical thinking’ in title and abstract. Papers were excluded if they: lacked a definition of critical thinking; were evaluation studies focused on developing and/or testing tools or instruments to assess critical thinking without defining the term; or broadly described teaching programs involving critical thinking without defining the term, identifying its elements, and/or context. After criteria were defined, the *Academic search complete* database was used to check whether previous searches had generated a good number and cross-section of papers. This database was deemed suitable because of its access to over 20,000 journals, mostly full-text and peer reviewed, covering the humanities, social sciences, science, engineering, business and management.

### 3.2 Data extraction procedures and conceptual framework guiding analysis

Search results were neither quantified nor recorded in keeping with scoping review protocols. Following scanning, 51 papers selected for definitions of critical thinking were uploaded to *EndNote* and listed in a document table covering the following disciplines/professional areas: preservice teacher education (science, kindergarten special education, moral education); higher education (accounting, agricultural science, architecture, art criticism, biology, business, home economics, industrial engineering, mathematics, law, online interactive learning, philosophy, psychology, physics, postgraduate research and doctoral education, sustainability experiential learning and technology); and adult education (art engagement, nursing, allied health and medical practices, respiratory therapy, community education, English language learning and Jiu Jitsu training).

Data in the form of direct quotes were extracted from the 51 papers in relation to the study goals, and inserted into a table categorised according to a conceptual framework shaped by three questions: Why (and for whom) is critical thinking important? How does critical thinking occur? What is critical thinking? Qualitative thematic analysis of extracted data was framed first, by the question of *why* critical thinking was important to each in disciplinary and professional context, to avoid making assumptions about its relevance [13], to identify commonalities and differences in its importance, and to develop conceptual coherence around its central positioning in learning. This enabled a distillation of the underlying principle/s at the core of critical thinking, which resulted in the articulation of eight interrelated conceptual elements. Next, an analysis of disciplinary descriptions of critical thinking enabled an understanding of *how* commonalities and differences could be recognized. Finally, *what* guided a search for practical examples that illustrated critical thinking and/or its interrelated elements in action across disciplines and practices. The outcome is a working model that represents both a distillation of what is known about the concept in various contexts and the beginnings of a research probe for the university-school partnership to track critical thinking in action in learning, among other 21<sup>st</sup> century capabilities.

## 4 DEVELOPING A WORKING MODEL OF CRITICAL THINKING IN ACTION

Development of the model began with definitions of critical thinking from three key streams of thought: philosophy, cognitive psychology and education. In philosophy, critical thinking has been framed as “formal rules of logic and the presence or absence of logical thinking fallacies ... involves meeting certain standards of accuracy in thinking”. In psychology ([14], p. 6) “the use of those cognitive skills or strategies that increase the probability of a desirable outcome ... purposeful, reasoned, and goal directed – the kind of thinking involved in solving problems, formulating inferences, calculating likelihoods, and making decisions”. In education ([15] p. 170), “Bloom’s (1956) taxonomy of information processing skills, ranging from ‘comprehension’ to ‘evaluation.’ Within that taxonomy, analysis, synthesis, and evaluation are types of critical thinking; focused on the developmental processes of

thinking, the impact of developmental stages on critical thinking skills, and the evolving processes of sense- and meaning-making in life". Adapted from Lai [16], Table 1 presents each approach by author and definition.

*Table 1. Definitions of critical thinking according to philosophy, cognitive psychology and education.*

<b>Approach</b>	<b>Author</b>	<b>Definition</b>
Philosophy	McPeck (1981)	The engagement of reflective scepticism
	Ennis (1985)	Reasonable, reflective thinking aimed at deciding what to do/believe
	Scriven & Paul (1987)	Clear, rational, open-minded thinking informed by evidence
	Facione (1990)	Judgement that is purposeful in nature and self-regulating in practice, that explains something based on evidential, conceptual/criteriological or contextual consideration
	Paul (1992)	Self-directed, disciplined, and appropriate to a given situation/domain
	Raiskums (2008)	Willingness to remain open to alternative perspectives and either integrate those perspectives into one's beliefs, or replace them with the alternative perspective in light of new evidence
Cognitive psychology	Sternberg (1986)	The way an individual could or should think, and the types of behaviours or actions they do in that process
	Halpern (1998)	Application of cognitive skills or strategies which improve an individual's ability to make informed decisions
	Brookfield (2003)	Series of steps in a process allowing individuals to become critically reflective when analysing and assessing beliefs and values
	Willingham (2007)	Deducing and inferring conclusions based on evidence that is free from subjective passion or bias via a structured thought process
Education	Bloom (1956)	Knowledge, comprehension, application, analysis, synthesis, evaluation
	Dewey (1991)	Learning and critical thinking are not segregated from an individual's subjective internal processes; each brings a range of personal experiences and cultural heritage that influences how they access that learning and critical thinking

A range of taxonomies to support and track the development of critical thinking exist as, for example, a learning continuum [17], a matrix of cognitive skills against values of inquiry such as clarity, accuracy, precision, depth (complexity, relevance and significance), coherence and breadth (alternatives, perspectives, collaboration) [18] and as a model [19]. The working model of critical thinking in action reported here seeks to support the development of this capability in complex, messy, ill-defined real-life situations (often involving wicked problems) where solutions or decisions are not clear cut.

Critical thinking was often articulated as a set of both skills and dispositions in, while a key debate is whether critical thinking can be considered a domain-general skill, similar to reading or maths, which can be applied to multiple contexts, or a domain-specific skill, which requires content knowledge, vocabulary and subject matter expertise [15]. The working model reported here aimed to reframe critical thinking in action as a set of transdisciplinary principles, practices and perspectives, rather than the skills and dispositions of individuals. This enabled a shift in thinking about how critical thinking can be framed as a set of element-actions, where each element requires some action, and may also contribute to other element-actions. The eight elements of critical thinking in action are: suspending judgement, holistic thinking, recognising assumptions, identifying bias/considering values, analysing, judging/evaluating, recognising patterns, and inferring. Each are derived from the references listed in the tables.

#### **4.1 Suspending judgement**

**Why.** Ambiguity, doubt and scepticism are necessary and productive, and perform a moderating role in critical thinking by showing certainty about ideas, values, and actions is not assured because they arise and articulate in networks constituting culturally shared perspectives produced within broader worldviews. Requires a shift from specific solutions to scenarios where both means and ends are subjects of inquiry in a productive dialogue to determine the issue at hand before proceeding to a response, sourcing better information to support decisions on what to believe or do, that also move beyond knowledge and toward empowering social action.

**How.** Fantasizing, empathizing, imagining the unfamiliar and inexperienced, seeking innovative/unusual options, and advancing with common objects in the environment.

**What.** Staying open, being sceptical, asking open-ended and critical questions, clarifying where relevant, and sitting with ambiguity and complexity.

*Table 2. Descriptors for suspending judgement.*

<i>Descriptor</i>	<i>References</i>
Sitting with ambiguity, being skeptical, recognizing perspective	[20, 21, 22, 23, 24]
Being open-minded, habitually inquisitive, flexible, fair-minded, self-aware, while maintaining credibility/honesty	[25, 20, 26, 27, 28, 29, 22, 30, 31, 32, 33, 34]
Asking open-ended and critical questions	[35, 36, 27, 37]
Identifying issues and relevance, information gathering	[38, 39, 31]
Problem framing, embodied, experiencing/taking on different frames/perspectives, seeking clarification	[39, 40, 41]

## 4.2 Holistic thinking

**Why.** Crossing cross- and multi- frontiers to transdisciplinary spheres of intellectual inquiry to bridge logical gaps in information and test relationships between statements that exercise influence/constraint on perceptions and shape customs to avoid problems or find solutions earlier. Empathy is crucial for the accurate appraisal of feelings and emotions that are signposts for motivation, and to guide justice and responsibility through compassion and caring.

**How.** Wearing different intellectual hats, thinking more deeply, recognising the complexities of different perspectives, considering all sides, paying attention to social and physical environments, rejecting poor explanations or claims without evidence, and identifying relevant perspectives and their underlying worldviews, facts, experts, authorities and courses of action. Willingness to reconsider, challenge others and continue learning; openness to change, and developing cultures of thinking through language and environments that value, make visible, and actively promote critical thinking as an everyday experience.

**What.** Paying attention to cultural forces (language, time, environment, opportunities, routines, modelling, interactions, expectations) in learning situations. Putting oneself in the place of others with regard and concern, decentering from one's own context and perspective to accurately reconstruct others' viewpoints, reasoning, perspectives and passions through experiential and embodied approaches enable an imagining of others from a quasi-first-person perspective that approximates their affective and cognitive states while also self-regulating one's own emotions and cognitive responses.

*Table 3. Descriptors for holistic thinking.*

<i>Descriptor</i>	<i>References</i>
Thinking generatively [creative thinking] and making this thinking visible	[39, 28, 42, 43, 44]
Moving beyond disciplinary boundaries and considering different perspectives and contexts	[15, 39, 45, 29, 24, 46]
Bridging gaps and establishing correspondence and cultures of thinking	[45, 20, 29]
Positive thinking, developing intellectual and emotional empathy	[25, 38, 45]

## 4.3 Recognising assumptions

**Why.** Once identified and brought to the surface, assumptions may be evaluated against a range of criteria (practicality, ethics, bias, logic) that explain why an issue is important.

**How.** Identification of premises of opposing arguments to ascertain the most convincing explanation.

**What.** Identifies unsaid world views and values that underpin claims; may occur by conducting live debates that can vividly demonstrate the need to admit in principle that premises do not always constitute good grounds for conclusions.

Table 4. Descriptors for recognising assumptions.

<i>Descriptor</i>	<i>References</i>
Identifying issues	[39]
Recognizing and exploring assumptions (ours and others)	[29, 47, 22, 23, 48, 33, 49]
Maintaining credibility/honesty, being accountable, confident	[15, 29, 22, 32]

#### 4.4 Identifying bias / considering values

**Why.** Distinguishing perspectives articulated in networks enables critical examination of the worldviews that underpin them, allowing one to hold and develop values while simultaneously developing capacity to critically discern others' positions and determine whether they are strong or weak, right or wrong. Identifying bias and considering values enables one to correct, modify and update the accuracy of one's knowledge to more accurately represent the world in which one lives [9], and shields critical analysis of this knowledge from being a random description of unrelated intellectual ephemera.

**How.** Cognitive, dispositional, motivational, attitudinal, and metacognitive functions [30] to become aware of fallacies and biases contributing to inaccurate beliefs or erroneous decisions; depends on accurate knowledge, soundness of reasoning, determination of sources of power, knowledge and legitimation, emancipation and worldviews, as well as purposes and beneficiaries, relevance of facts, and underlying worldviews.

**What.** Identifying what is important to, and the agenda for, each perspective/worldview.

Table 5. Descriptors for identifying bias / considering values.

<i>Descriptor</i>	<i>References</i>
Metacognition	[25, 43, 50, 32]
Analyzing perspective and supporting values	[24, 46, 50]

#### 4.5 Analysing

**Why.** To test the utility of rules and institutions, guide to belief and action, understand large-scale systems, improve attention and observation towards a desirable outcome, analysing must be guided by an informed interest on the part of the analyst.

**How.** Based on universal intellectual values that transcend subject matter divisions (clarity, accuracy, precision, consistency, relevance, sound evidence, good reasons, depth, breadth, and fairness).

**What.** Logical reasoning in listing, categorising, linking, calibrating: arguments, causation, claims, options, evidence. Asks: what are the specific findings/results; how was analysis conducted; what is the best way to characterise/classify; how was that interpretation arrived at; what does this mean; what is intended by doing that in this context; explain the reasoning behind why this particular decision was made; what made the solution right; how can one make sense out of the experience?

Table 6. Descriptors for analysing.

<i>Descriptor</i>	<i>References</i>
Purposeful, goal directed interpreting	[35, 51, 14, 15, 22, 44]
Information chunking and processing	[15, 38]
Conceptualising/ abstracting, generating beliefs	[28, 36, 38]
Analysing and challenging	[39, 22, 23, 44, 48, 50]
Justifying reasoning	[39, 42]

## 4.6 Judging / evaluating

**Why.** Promotes independent thinking and personal autonomy, gauges the reliability of another's account, influences others' decisions/actions to obtain change, resulting in a tangible product providing direct evidence of the cognitive processes engaged in to get there.

**How.** Presence/absence of logical thinking fallacies, reflecting on what to do or what to believe, investigating and solving technical problems, and responding to expected situations requiring organized thinking and unexpected situations requiring rapid thinking.

**What.** Purposeful, self-regulating distillation of quality, ordering, prioritising, making decisions, and recursivity to assess the credibility of claims made and reach a final outcome. Asks: how credible is that claim; why can this claim be trusted; how strong are the arguments; are the facts right; how much confidence can be placed on the conclusion, given what is now known?

*Table 7. Descriptors for judging/evaluating.*

<i>Descriptor</i>	<i>References</i>
Formal rules of logic, prioritizing, negotiating, troubleshooting	[15, 29]
Challenging information accuracy, and credibility, reliability of claims	[39, 25, 22, 42, 44, 50, 48]
Judging	[10, 26, 27, 279]
Making decisions	[39, 45, 27, 29, 33]

## 4.7 Recognising patterns

**Why.** Being able to visualise, recognise and communicate patterns and relationships enables a formulation of interpretations or hypotheses about the meaning of the evidence; seeing beyond the obvious, thinking outside the box, and verifying relationships between statements.

**How.** Investigation of events from disparate contexts, recommending many alternative solutions, fluency in the creation of a large number of ideas, flexibility in creating ideas from disparate categories or approaches, novelty in creating unusual or rare ideas, and elaboration in creating ideas in specific form that explore a situation, phenomenon, question, or problem to arrive at a hypothesis or conclusion that integrates all available information and can be convincingly justified.

**What.** Noticing, conceptual mapping, visualising rhythms, connections, anomalies, discerning the boundaries of decisions to determine how to set out what may apply to a new scenario and reflecting on one's work, past decisions, and profession to learn from previous mistakes and problems.

*Table 8. Descriptors for recognising patterns.*

<i>Descriptor</i>	<i>References</i>
Visualizing thinking/patterns	[28, 34]
Correspondence [relevance]	[45, 28, 29, 42, 50]

## 4.8 Inferring

**Why.** Moves towards an outcome, generates decisions based on the assessment of multiple viewpoints in a thorough, rational, and definable manner that avoids equivocation, irrelevance, circularity, reversal of causal relationships, the straw person, fallacy, overgeneralization, excessive scepticism, credibility problems and use of emotive language to persuade.

**How.** Synthetic process and creative act relying on insight, identifies and adapts context and framework in which decisions are made, develops criteria and/or governing values driving decisions, recognizes and evaluates consequences of decision-making and actions, makes evidence-based suppositions of likely outcomes, brings together facts and qualities from interpretation, analysis, evaluation to construct meaning and significance in an original conclusion about the object of critique or course of action.

**What.** Inductive/deductive reasoning that conjectures alternatives, and queries and uses evidence, causal explanation, analogy and patterns to make credible claims. Asks: what is being claimed; explain

the reasons for the claim; what are your arguments pro and con; what assumptions must be made to accept that conclusion; does the conclusion make sense; what is the quality of information used to support the conclusion; were the right questions asked; were enough questions asked; should the information be reviewed; was there more than one possible conclusion?

Table 9. Descriptors for inferring.

<i>Descriptor</i>	<i>References</i>
Synthesizing/ unifying/concluding [collating for outcomes]	[50]
Explaining, reasoning [formulating conclusions]	[39, 45, 22, 24, 44, 48]
Problem solving and assessing critical thinking	[15, 26, 34, 46]
Planning implementation [applying new knowledge]	[39]

## 5 TESTING THE WORKING MODEL

The working model presented here will be tested in an empirical study of critical thinking development in the context of a selected school's Challenge Project involving industry partners to engage young people in complex projects, opportunities and problems relevant to 21<sup>st</sup> century issues. Project will run for four school terms over a year (approximately 10 weeks each), where students engage in problems that exist in their communities. In such projects, problems are ill-defined, complex and messy. The four projects are: a school-constructed project with a problem posed by an industry partner; a student and teacher constructed project where students work with a Council and/or industry partner on an existing local problem; and a two-term 'Passion Project' in which students individually and collaboratively develop, plan and implement a self-selected project, supported by school mentors and industry partners.

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