An Ontological and Epistemological Interrogation of Explicit Teaching in Mathematics

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Much is claimed about the efficacy and efficiency of Explicit Teaching in schools. Recommendations for pedagogy emphasising explicit instruction have been widely adopted by education systems across Australia, commonly citing evidence from the Australian Education Research Organisation. But what does Explicit Teaching say about ontological and epistemological questions such as learning, knowledge and how knowledge is developed? This paper uses an imagined dialogue between Critical Realism and Explicit Teaching to seek to articulate the philosophical underpinnings of Explicit Teaching in mathematics.

Much is claimed about the efficacy and efficiency of Explicit Teaching in school mathematics. Proponents of Explicit Teaching advocate classroom practices that include articulating clear learning intentions and success criteria, modelling procedures and gradual release of responsibility through approaches such as "I do, We do, You do" (Ashman, 2020). It is not the purpose of this paper to provide a commentary on the empirical evidence cited in support or otherwise of Explicit Teaching. Nor is it the purpose of this paper to discuss the efficacy or otherwise of pedagogical approaches recommended by proponents of Explicit Teaching. Rather, the paper seeks to articulate the ontological and epistemological underpinnings in the literature and advocacy of Explicit Teaching in mathematics.

In this paper I use the capitalised form Explicit Teaching with reference to an approach that not only describes classroom interactions but is also a de facto organising principle in that it structures and in some cases scripts lessons (e.g. Ochre Education, n.d.). This distinguishes Explicit Teaching in its capitalised form from explicit teaching (lower case) that forms a part of many, if not most, mathematics teaching episodes. Indeed, if one interprets the term "explicit" using its etymology—*ex* meaning *out* and *plicare* meaning to *fold*—then guided inquiry or other approaches criticised in the literature cited by proponents of Explicit Teaching (e.g. Kirschner et al., 2006) could be considered highly explicit as they aim to "fold out" the mathematics inherent in a situation (Hmelo-Silver et al., 2007).

In my interrogation of the ontological and epistemological underpinnings of Explicit Teaching I draw on the theoretical framework of critical realism (Bhaskar, 2008) and its articulation of the nature of the material and social world, and of how humans come to know and use our understanding of the world. I make no claims regarding the value or truth of critical realism as opposed to other ontological or epistemological positions; rather, I use it to frame questions that might contribute to a more nuanced view of the philosophical underpinnings of Explicit Teaching in mathematics. While other philosophical positions in the sciences or social sciences could equally well be employed, I use critical realism because it simultaneously addresses questions of ontology, epistemology and the central importance of rationality. I also use critical realism as it originated as a philosophy of science and social science that seeks to question both the positivist view of science as monistic in its development and deductive in its structure and a relativist view of science that denies the existence of universal principles. As Explicit Teaching claims to enact recommendations based on what is often termed the science of learning (or reading, or mathematics), and hence to claim a scientific basis for its recommendations, it is reasonable to interrogate it using a philosophy of science.

(2026). In N. Berger, M. Thompson, J. Ley & C. Wilsmore (Eds.), *Beyond boundaries: Strengthening futures in mathematics education. Proceedings of the 48th annual conference of the Mathematics Education Research Group of Australasia, Sydney* (pp. 401–408). MERGA.

I frame the paper using the rhetorical device of an interrogation in order to ask close, specific and direct questions, rather than presenting a more open-ended discussion or analysis. In this paper, the interrogator is an imagined personification of critical realism (CR), and the interrogee is the imagined personification of Explicit Teaching (ET). The personification of CR is based on the three principal tenets of critical reasoning outlined below, while the personification of Explicit Teaching is drawn from the Australian Education Research Organisation (AERO) website (Australian Education Research Organisation, n.d.-a), which is, in turn, widely advocated in the media and by some education systems (e.g. Victoria Department of Education, n.d.; WA Department of Education, n.d.) as the evidence-based pedagogy that *ought* to be adopted in all schools. Again, it is not my intention to discuss normative questions of whether or not Explicit Teaching ought to be the recommended or mandated organising principle and pedagogy in schools; rather, in seeking to uncover the ontological and epistemological underpinnings of Explicit Teaching, I seek to shed light on how Explicit Teaching might shape our experience and understanding of mathematics in and beyond school and in the material and social world.

Current policy efforts to improve mathematics outcomes in Australian schools has cast increased attention on pedagogical approaches. Inquiries such as the Quality Initial Teacher Education Review, together with reports providing a "guaranteed" method for boosting student learning in primary school mathematics (Hunter et al., 2025) have, as noted above, led to the advocacy of Explicit Teaching by systems and the media. At the same time, groups such as the Mathematics Education Research Group of Australasia have argued that one narrow approach cannot address the full range of aims and proficiencies in the Australian Curriculum: Mathematics v9 (2026) such as mathematical modelling, computational thinking or statistical investigations (Mathematics Education Research Group of Australasia, 2023). Such debates therefore take on both an educational and a political dimension, making an examination of the philosophical underpinnings of Explicit Teaching both timely and apposite.

Critical realism – ontological reality, epistemological relativism and judgmental rationality

The interrogator in the imagined interrogation, critical realism, makes a clear distinction between what Bhaskar (1989) describes as the transitive world of knowing (epistemology) and the intransitive world of being (ontology). In education, and particularly in educational research and school curriculum, where knowledge adopts primary importance, this distinction is crucial. When, for example, measurable outcomes such as scores on standardised tests are assumed to fully capture the reality of teaching methods or educational innovations, this reduces the reality of schooling (ontology) to what we can know about it (epistemology) and commits what Bhaskar terms the *epistemic fallacy* (e.g. "if we can't see it, it's not real"). By contrast, the *ontic fallacy* ignores the cognitive and social mechanisms by which knowledge is produced leaving only a set of apparently objective facts (as if "the facts for themselves"). For example, when questions such as how standardised tests are constructed, what they measure, how they are administered or how the data are analysed, are ignored or glossed over, test scores then becoming objectified as a direct and unmediated representation of reality.

A failure to clearly articulate epistemological and ontological positions in educational research or curriculum then runs the risk of committing such mutually reinforcing fallacies (Scott, 2010). Critical realism claims to address these fallacies by combining and reconciling three principal standpoints: ontological reality, epistemological relativism and judgmental rationality. First, ontological reality refers to the nature of the material and social world. Critical realism holds that phenomena in the material and social world exist independently of our ability to explain them. In the case of mathematics, we could also add phenomena in the conceptual world (Thornton, 2022). Second, epistemic relativism refers to how we come to know the world.

It acknowledges that all our concepts are historically and socially generated, hence are relative to a particular perspective and subject to change. As our conceptual toolkit changes, either/both individually and collectively as a society, so does our understanding of the world. Third, judgmental rationality asserts that science is not arbitrary and that there are rational criteria for judging some theories as better or more explanatory than others. Different research methods, for example, reveal different aspects of the world and can be more or less descriptive or explanatory depending on the context.

According to Scott (2010), critical realism therefore:

"possesses a superior grasp of:

- the relationship between ontology and epistemology central to an understanding of the social world, and in particular, education;…
- the constitution of knowledge and its formation, and the implications of both of these for the school curriculum; and
- the need to adopt a critical approach to both education and the way it is understood. (p.11-12)

Approach

As noted above, the imagined personification of Explicit Teaching is drawn from papers publicly available on the Australian Education Research Organisation (AERO) website (Australian Education Research Organisation, n.d.-a). While I acknowledge that explicit instruction is only one element of AERO's published model of teaching and learning, I claim that, taken as a whole, the model represents what is typically understood as Explicit Teaching in its broader and structuring sense. For example, the four elements of "Teaching that aligns with how students learn" are headed: "Enabling, Planning, Instruction and Gradual Release" (Australian Education Research Organisation, 2023c), which then become a universal structure for the illustrative lesson plans on the AERO website. Furthermore, the model has been "widely adapted and taken up by jurisdictions in their own teaching and learning models" and "AERO has taken a deliberate and structured approach to advancing evidence-based teaching, including explicit instruction—one of the most effective ways to improve student learning" (Australian Education Research Organisation, n.d.-b, p. 7,14).

I do not claim to have completed an extensive meta-analysis of the evidence for Explicit Teaching, nor a systematic review of literature on the AERO website. Such endeavours may be opportunities for further research. Rather, I searched papers of specific types on the AERO website containing specific terms that might shed light on ontological and epistemological perspectives. I chose to focus on a subset of the materials available on the AERO website that would be most likely to explain the basis for its teaching and learning recommendations: these were Articles, Explainers, Practice guides, Research reports, and Research summaries. Practice guides are included as they purport to synthesise "the most rigorous and relevant evidence-based practices from meta-analyses, systematic reviews and literature reviews" (Australian Education Research Organisation, n.d.-a).

Table 1 shows the number of materials sourced from the AERO website by search term and by resource type. Of course, many materials are referenced twice in the below table.

Table 1: Materials obtained from the AERO website by search term and resource type.

Search term	Articles	Explainers	Practice guides	Research reports	Research summaries	TOTAL
Learning	65	24	83	31	16	219
Evidence	66	23	57	35	16	197
Knowledge	37	19	52	12	23	143
Explicit	22	15	33	8	5	83
Mathematics	4	8	10	7	2	31
Reality	2			3		5
Judgment		1		1		2

Having identified materials likely to shed light on questions of ontology or epistemology, I identified specific instances in the materials that I felt most clearly captured the ontological or epistemological thrust of the materials taken as a whole. I then used these as the responses in the imagined interrogation.

Interrogating Explicit Teaching

In the imagined interrogation that follows, the questions asked by Critical Realism (CR) are framed by the three key principles of critical realism: ontological reality, epistemological relativism, and judgmental rationality. As the AERO website claims to enact both a knowledge-rich and evidence-based approach, two questions are asked relating to each of these principles: the first relates to the view of knowledge and learning underpinning Explicit Teaching, the second to the evidence in support of the pedagogical practices of Explicit Teaching. Table 2 shows the framework through which the questions were generated.

Table 2: Questioning framework for the interrogation

	Ontology	Epistemology	Judgmental rationality
Knowledge and learning	?	What is knowledge?	How do students learn to become critical users of mathematics?
Evidence	What evidence supports Explicit Teaching?	How do you decide what counts as valid evidence?	How do teachers exercise judgment?

To ensure that the responses provided by the imagined personification of Explicit Teaching (ET) are not simply my interpretations, all responses are direct citations from materials sourced from the AERO website. As noted above, these citations represent a best approximation and clearest representation of the general ontological and epistemological thrust of the AERO materials taken as a whole.

Rather than adding an interpretation of the interrogatory exchanges following each question, I invite the reader to consider the responses as a whole. Some tentative conclusions and implications follow the exchange.

On ontological reality

CR: AERO's stated vision is "for Australia to achieve excellence and equity in educational outcomes for all children and young people through effective use of evidence" (Australian Education Research Organisation, 2025b, p. 6). Specifically, AERO's constitution states that its specific purpose is to "improve *learning* outcomes for all children and young people" (Australian Education Research Organisation, 2025b, p. 2, italics added). What is *learning*?

ET: Learning is a change in long-term memory (Australian Education Research Organisation, 2023c).

Learning happens when new knowledge is acquired, processed and retained in memory for later use (Australian Education Research Organisation, 2023b, p. 1).

There are 2 types of memory that manage information during learning:

- working memory, which processes information
- long-term memory, which stores information for later use (Australian Education Research Organisation, 2025a, p. 2).

CR: The AERO website tagline is "Evidence and resources educators can trust" (*Australian Education Research Organisation*, n.d.-a). What evidence is used to support Explicit Teaching?

ET: To uphold Australia's commitment to educational excellence, equity and lifelong learning – as articulated nationally by the Mparntwe Declaration—curriculum design *must* be underpinned by the *cognitive science* on how students learn (Lonsdale et al., 2024, p. 21, italics added)

Understanding the science behind learning and memory can help teachers understand why spacing and retrieval practice are so effective in helping students learn and remember information (Australian Education Research Organisation, 2022a)

Explicit instruction is a very efficient strategy for helping students learn because it suits how the brain processes, stores and retrieves information (Australian Education Research Organisation, 2022b).

On epistemic relativism

CR: Explicit Teaching asserts that knowledge is central to learning, arguing for a "knowledge-rich curriculum" (Lonsdale et al., 2024). What do you understand by knowledge, who decides what knowledge is important to learn and how does knowledge develop?

ET: Knowledge is the subject-specific information, concepts and principles that students are *expected* to know and understand at each stage of their schooling (Lonsdale et al., 2024, p. 6, italics added).

Explicit instruction…involves fully explaining and effectively demonstrating what students *need* to learn (Australian Education Research Organisation, 2023a, p. 1, italics added).

Knowledge is acquired in a logical and structured way when learning follows predictable progression patterns, moving from understanding foundational concepts to more complex applications (Australian Education Research Organisation, 2025c, p. 3).

CR: AERO asserts that "[g]reater uptake of evidenced-based teaching practice improves learning outcomes in schools" (Australian Education Research Organisation, 2025b, p. 5). How do you decide what evidence is valid, reliable and important to implement?

ET: At the Australian Education Research Organisation (AERO), we believe research evidence and context are important teammates… 'Evidence-based practices' are backed up by research evidence. This means there is broad consensus from rigorously conducted evaluations that they *work* (Australian Education Research Organisation, 2022c, italics added).

AERO's Standards of Evidence establish our view on what constitutes rigorous and relevant evidence…*Rigorous* evidence is defined as evidence produced using research methods (whether qualitative, quantitative or mixed methods) that isolate the specific impact of a particular educational approach. *Relevant* evidence is defined as evidence produced in contexts that are similar to one's own (Australian Education Research Organisation, 2024a, p. 1, italics in original).

On judgmental rationality

CR: The Australian Curriculum Mathematics v9 (2026) includes many priorities that go beyond acquisition of knowledge and require students to make judgments. These include the proficiencies of problem solving and reasoning described in the key considerations for mathematics, mathematical modelling, computational thinking, the statistical investigation process, probability experiments and simulations, and the use of digital tools. How are these priorities developed through Explicit Teaching?

ET: Curriculum development should sequence learning appropriate to the hierarchical, cumulative nature of maths. Teaching and learning plans should first explicitly teach related skills and knowledge and give opportunities to practise. Open and complex tasks with many possible paths to solutions should *follow* (Australian Education Research Organisation, 2024b, p. 5, italics added).

As students progress towards mastery, they can demonstrate their understanding in increasingly sophisticated ways. Automating knowledge in long-term memory enhances their ability to solve complex, unfamiliar problems and generate new insights that reflect deep learning. These skills support

lifelong learning and success both in and beyond the classroom (Australian Education Research Organisation, 2025d, p. 4).

CR: The Australian Association of Mathematics Teachers position statement on Pedagogy in Mathematics (2025) states:

> No single pedagogical approach can meet the needs of every mathematics learner. Effective mathematics teaching relies on a range of intentional and high-quality practices that can be tailored to specific contexts, learners and purposes…Teachers are encouraged to develop and deploy a diverse repertoire of strategies, grounded in both research and practical insights, to create responsive mathematics learning environments for all students (p.1).

How do you respond to that statement?

ET: Evidence is important, but what is more important is […] teacher expertise and professionalism [to] make better judgments about when, and how, to use research (Gleeson et al., 2022, citing Wiliam, 2019)[4].

AERO has developed Standards of evidence and Evidence decision-making tools that aim to guide teachers and educator's assessment of the confidence they should have that a particular practice will 'work' based on the amount, rigour and contextual relevance of research evidence available (Australian Education Research Organisation, 2022, p. 18).

Conclusion and further directions

My reading of the materials relating to Explicit Teaching on the AERO website through the lens of critical realism reveals three foundational ideas:

3. *Knowledge is the cornerstone of the advocacy of Explicit Teaching.* However, who decides what knowledge is worth acquiring and why remains unquestioned, resulting in simplistic statements such as "the knowledge that students *need* to learn" as cited above. Consequent on this view of knowledge is the equating of learning with a change in long-term memory and a model of the brain as a storage device, which in turn suggests that a collection of facts or concepts residing in the individual mind is a faithful representation of reality. But this is not the only potential conception of the human mind. As Donald (2001, p. xiii) argues "[T]he human mind has a collective counterpart: culture…The key to understanding the human intellect is not so much the design of the individual brain as the synergy of many brains". And "questions about knowledge always take us back to some of our most basic assumptions about what it is to be educated or to educate someone; they are, in the broadest sense, philosophical and political questions about who we are and what we value" (Young, 2008, p. xvii).
4. *We acquire knowledge in a consistent and predictable way through clear explanation, modelling, practice and intervention as required.* The logical consequence is that we share a common view of the world that can be transmitted through structured Explicit Teaching. Again, this is by no means the only defensible epistemological position. Brandom (2000), for example, argues for an epistemology founded on inference rather than reference (that is, in making a conceptual claim one is explicitly endorsing a set of inferences that articulate its conceptual content). "For a commitment to become explicit is for it to be thrown into the game of giving and asking for reasons as something whose justification, in terms of other commitments and entitlements, is liable to question" (Brandom, 2000, p. 76).

[4] Gleeson et al. is a report commissioned by AERO. The citation from Wiliam (2019) is from an opinion piece headed "Teaching not a research-based profession", in which he says, "Classrooms are just too complicated for research ever to tell teachers what to do".

5. *We make judgments* following *acquisition of knowledge.* For students, this means learning foundational knowledge prior to engaging in higher order tasks involving critical thinking, synthesis or evaluation. For teachers, judgment is pragmatic. While being encouraged to assess whether a particular practice will *work*, to assess the *usability* of research evidence and to make judgments about *when*, and *how*, to use this research, there is little scope for teachers to consider the potential contribution of research to questions beyond those of improved outcomes on standardised measures of achievement.

Taken together, these foundational ideas suggest what I would term a realist but blinkered ontology, an absolutist epistemology, and a judgmental pragmatism. However, these conclusions are almost entirely implicit. The AERO website is entirely silent on questions of ontology and epistemology—no results were returned in a search of the website for these terms. In its silence on these matters, Explicit Teaching then becomes not only a pedagogy and an organising principle, but a de facto self-referential philosophy of mathematics education, perhaps best expressed as "The purpose of education is to acquire knowledge; knowledge is the set of skills and concepts that students need to learn; learning happens when those skills and concepts are stored in memory".

The absence of any external referent creates what I suggest is an ontological and epistemological chasm in the advocacy of Explicit Teaching. This then places this self-referential philosophy on very shaky ground. Indeed, it is difficult to see how Explicit Teaching, as advocated on the AERO website, can address deeper questions of purpose and culture espoused in the rationale for mathematics education described in curriculum documents such as the Australian Curriculum v9 (2026). This is not to say that questions of purpose and culture cannot be addressed in Explicit Teaching, rather it seems that they have yet to be asked.

In fairness one could argue that most published mathematics education research is silent on questions of epistemology and ontology (Thornton et al., 2016). Hence, it may be timely to reframe the rhetoric around "explicit teaching". The dichotomous view and apparent incompatibility of inquiry or problem-based approaches to teaching mathematics and Explicit Teaching as advocated by the sources discussed above, is neither helpful nor productive. I would argue that even a blended or balanced approach suggesting that there is a place for both fails to adequately address the apparent impasse. Rather, it is timely to consider questions of ontology, epistemology and rationality, and hence to re-examine teacher and student roles in an articulation of "explicit" that captures its origins as "unfolding".

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