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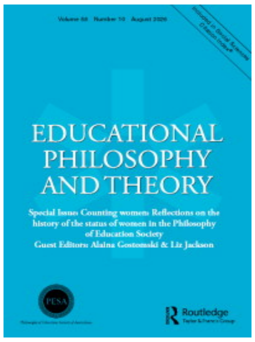

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Rethinking education through multi-level analysis of the impacts of epistemological assumptions on curricula

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ABSTRACT

Assumptions about the nature and acquisition of knowledge—'epistemological assumptions'—profoundly influence education, particularly through curricula. However, this influence is indirect and implicit, thus requiring careful tracing to uncover its impacts. Although prior research has examined from different perspectives the influence of epistemological assumptions on curricula, few studies have systematically traced their effects across key curricular dimensions, extending down to their impacts on student learning. This paper introduces a multi-level framework that traces the influence of epistemological assumptions across five interrelated levels: (a) epistemological assumptions, (b) educational epistemological assumptions (assumptions about how knowledge should be taught and learned), (c) pedagogical principles, (d) instructional methods, and (e) effects on student learning. The framework's utility is demonstrated by comparing curricula informed by empiricist epistemological assumptions with those of developmental education (DE), or (Neo-)Vygotskian approaches, grounded in dialectical–materialist assumptions, opposed to empiricist epistemologies. This multi-level comparative analysis illustrates how alternative epistemological foundations can produce significant cascading effects on teaching and learning, with DE curricula here mitigating recurrent difficulties common in empiricist-informed education. By showing how distinct epistemological assumptions shape curricula and student learning, this framework provides a valuable tool for critically analysing curricula, exploring alternatives, and rethinking educational theory and practice.

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Introduction

Assumptions about knowledge and knowledge acquisition—'epistemological assumptions'—underpin theories of learning and teaching, thereby contributing to shaping educational design and practice[1] (Bruner, 1985; Phillips, 2003; Schunk, 2020). Curricula offer a privileged site for examining epistemological influences on education, as they

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are structured plans for education that articulate and integrate educational objectives, content, and instructional methods.

The influence of epistemological assumptions on curricula has been studied in relation to general curriculum theories and designs (Hirst, 1974/2010; Scott, 2014; Walker & Evers, 1982), content and teaching methods (Gattegno, 1984), how different epistemologically informed curricula may support student learning (Winch, 2013; Young & Muller, 2013), or critical reflections on normative epistemological assumptions implicitly shaping curricula (Giroux & Penna, 1979; Miller, 2005; Moncrieffe, 2022).

However, few studies have analysed this influence across multiple levels, extending through to specific impacts on student learning. Even fewer have provided an analytical framework for doing so. Such a framework is needed, because the influence of epistemological assumptions is indirect and implicit, and therefore requires careful tracing to uncover its chains of effect that can ultimately shape teaching and learning. This paper introduces a multi-level framework to trace the influence of epistemological assumptions across key interconnected dimensions of curricula, from underlying assumptions to impacts on student learning.

The utility of this multi-level framework is demonstrated by comparing the influence of empiricist epistemological assumptions on curricula with that of dialectical–materialist epistemological assumptions—explicitly opposed to empiricist assumptions—on curricula from developmental education (DE), or '(Neo-)Vygotskian approaches'. This multi-level comparative analysis shows markedly different implications for curriculum design and pedagogy, with distinct impacts on student learning. Specifically, DE curricula mitigate learning difficulties often associated with empiricist-informed educational applications. However, the goal is not to advocate for DE or criticise the diversity of empiricist-informed approaches but to introduce this framework as a valuable tool for critically analysing curricula, exploring curricular alternatives, and thereby rethinking educational theories.

The paper concludes by briefly discussing three contemporary curriculum topics—inquiry learning, collaborative learning, and AI-based instruction—to show that the usefulness of the multi-level framework extends beyond explicitly contrasted curricula to situations where distinct underlying chains of influence, including possible dissonances between levels, are not directly visible, yet make a difference for curricula and student learning.

A multi-level framework for analysing the influence of epistemological assumptions on curricula

The multi-level analysis presented here was motivated by the aim to provide a framework that traces the influence of epistemological assumptions on education, extending down to their impacts on student learning. It was inspired by several theoretical perspectives that study phenomena through their emergence and development across multiple levels of organisation (e.g. Bronfenbrenner, 1979; Jacobson et al., 2019). It also aligns with genealogical analyses, which critically investigate the historical emergence, transformations, and evolution of influences that shape the phenomena under study (Foucault, 2001; Varela, 2001). A preliminary version of the analysis behind this framework was described as a genealogical epistemological analysis of educational theories and approaches (Gennen, 2025, 2026). The following levels, which may be endorsed implicitly or explicitly and more or less systematically, have been delineated because they constitute key dimensions for tracing the influence of epistemological assumptions on curricula, to be examined in their interrelations:

1. Epistemological assumptions: Assumptions about the nature of knowledge and its acquisition, which constitute building blocks of learning theories (e.g. knowledge is acquired and developed through active reflection on one's experiences).
2. Educational epistemological assumptions: Epistemological assumptions underlie assumptions about how knowledge should be taught and learned (e.g. students better master academic knowledge[2] after undergoing a process of inquiry).
3. Pedagogical principles: Educational epistemological assumptions contribute to shaping general guidelines and principles that support student learning (e.g. students should learn through inquiry).
4. Instructional methods: Pedagogical principles orient the selection and implementation of certain means used for instruction[3] (e.g. specific tools and activities enabling hands-on explorations).
5. Effects on student learning: The application of pedagogical principles through specific methods and practices impacts the learning experience of students in distinct ways.

Corresponding questions can guide the analysis, which may attempt to trace these interrelations 'backwards' from observed practices and effects, or 'onwards' from underlying assumptions, such as: (a) Which instructional methods are used, and what effects on learning do they contribute to generating? (b) Do these methods presuppose or enact particular pedagogical principles? (c) Do these principles reflect particular views about how knowledge should be taught and learned? (d) What assumptions about the nature and acquisition of knowledge may be presupposed by these educational views?

Other important dimensions are connected to these levels. Pedagogical principles and educational epistemological assumptions are often associated with specific *educational goals* and can inform the selection of *curricular content*—both implicitly considered here—while the application of methods and principles occurs in *educational practices.*

Furthermore, the levels can be specified at varying degrees of detail, and some may be porous, with elements within them debatably categorised. For instance, an epistemological assumption may become a pedagogical principle simply by shifting from describing to prescribing (e.g. 'children learn better this way' → 'children *should* learn this way'). As another example, the effects on student learning addressed here cover academic knowledge understanding and mastery, including associated student difficulties, but could also encompass ethical or social dimensions. The framework's flexibility is not a weakness; rather, it makes it adaptable and open to refinement according to the needs of the analysis undertaken.

The epistemological commitments underlying this multi-level analysis assume that it is possible and useful to distinguish these different levels analytically and to analyse patterns of influence between them, including effects on learning. However, some limitations, calling for interpretive caution, are that one should not assume prior to analysis that these levels are necessarily causally connected; whether and how such connections hold must be examined in each case. Moreover, dissonances or contradictions can exist between these levels, especially in actual practices. In particular, teachers may be more or less aware of, or committed to, the instructional methods and underlying pedagogical principles and epistemological assumptions associated with a given curriculum. They may implement these principles and methods in ways that diverge from intended applications.

Thus, this framework should not be conflated with a prescriptive model to be applied mechanically. Rather, its goal is not to provide a rigid structure or a strict fit into categories, but to offer a tool for tracing the influence of epistemological assumptions on curricula through key interrelated dimensions, ultimately reaching student learning.

A multi-level analysis of the influence of empiricist epistemological assumptions on curricula

Empiricist epistemological assumptions

Empiricist epistemologies trace back to Aristotle and were prominently developed in seventeenth-century British classical empiricism—particularly in John Locke's theories (1690/1975). They have continued in various forms, as discussed in the literature (Fodor & Pylyshyn, 2015; Glover & Ronning, 1987; Pinar, 2014). Although diverse, they share core assumptions regarding the nature of knowledge and its acquisition (Fodor & Pylyshyn, 2015; Margolis & Laurence, 1999). Notably, knowledge is acquired through inductive generalisations from perceptual experiences or mental associations of concepts derived from those perceptual experiences. For example, the concept of the sun would comprise perceptually based concepts such as round, warm, and bright (Margolis & Laurence, 1999, pp. 8–10). Accordingly, types of knowledge differ in the degree of abstraction and generalisation of perceptually based concepts and the mental associations among them, which are based on similarities, contrasts, or contiguities between concepts. Therefore, academic concepts are generalisations derived from comparisons of particular situations and abstracted from the concrete instances they refer to. For example, the concept of capitalism constitutes a general formal category encompassing abstract features such as private ownership of the means of production and profit generation (Ilyenkov, 1960/1982).

Empiricist educational epistemological assumptions

One key assumption about how students should learn and be taught knowledge stems from these empiricist epistemological assumptions: students should learn primarily by relying on and directly building upon their existing knowledge, experiences, and reasoning—especially those familiar from everyday life. Grounding instruction in students' experiences and knowledge, particularly concrete and familiar ones, is assumed to facilitate a clearer and more meaningful understanding of academic concepts. This core empiricist educational epistemological assumption has taken several forms, impacting in several ways different curricula, including ‘learner-centred schools’ (Schiro, 2013), ‘experiential learning’ approaches (Pinar et al., 2008), and, more generally, ‘student-centred curricula’ (Gennen, 2025).

The influence of empiricist educational epistemological assumptions on curricula has several sources: (a) the impact of empiricist theories of knowledge on educational psychology until the mid-twentieth century (Bruner, 1960/1977; Glover & Ronning, 1987; Pinar, 2014); (b) the assumption in influential developmental theories, such as Piaget’s and Bruner’s, that children think concretely and have limited capacities for abstraction and generalisation, which has significantly impacted curricula (Davydov, 1972/1990; Glover & Ronning, 1987; Uttal et al., 2006); and (c) the historical link between empiricist influence on curricula and a utilitarian view of schooling, where the primary goal of education is to develop elementary skills such as reading, writing, and arithmetic (Davydov, 1964; El’konin, 1963/1999; Kridel, 2010).

Empiricist pedagogical principles and instructional methods: ‘from the concrete to the abstract’

The core empiricist educational epistemological assumption has shaped several pedagogical principles and instructional methods influential in curricula. One influential principle is to ground early and primary education in children’s everyday and concrete experiences, while gradually introducing the abstract and theoretical foundations of school disciplines in later grades by building on this prior elementary learning (Kridel, 2010; Pinar et al., 2008; Uttal et al., 2006). Here, ‘concrete’ refers to having perceptual referents or being experienced through perception.

For instance, mathematics curricula typically begin with arithmetic introduced through counting perceptible objects, with more abstract aspects—such as unfamiliar properties of numbers (e.g. rational numbers) and algebraic reasoning—introduced in later grades, building upon this concrete foundation (Kilpatrick et al., 1975; Kridel, 2010; Venenciano et al., 2021). Similarly, many language curricula prioritise students’ practical mastery of language components, such as classifying nouns, verbs, and adjectives, and developing reading and writing skills useful in everyday life (El’konin, 1963/1999; Mills & Unsworth, 2016; van Rijt et al., 2019). Systematic learning of linguistic theoretical aspects, such as morphological or syntactic rules, is generally reserved for later grades (Davydov, 1972/1990; Kirby & Bowers, 2017) or receives peripheral focus (van Rijt et al., 2019).

Empiricist assumptions have also underpinned many progressive education curricula in their emphasis on building upon students’ own experiences and reasoning, particularly through perceptual experiences as instructional methods (Howlett, 2014; Pinar, 2014; Pinar et al., 2008). For example, in Montessori schools, children manipulate concrete objects with various shapes, forming a foundation for abstract knowledge introduced in later grades (Montessori, 1912/2012).

Another empiricist-informed instructional method is the use of direct observation as the primary basis for inductive inferences, particularly in science education: observing phenomena, formulating hypotheses, testing them, and drawing conclusions (McComas, 2020; Schwab, 1978)—for instance, observing a swinging pendulum as the basis for abstracting scientific principles such as oscillation, frequency, and amplitude (Matthews, 2014).

Using visual images to represent features of academic knowledge concretely and vividly, to aid students in visualising, abstracting, and generalising them, is another empiricist-influenced method (Davydov, 1972/1990; Phillips, 2003; Pinar et al., 2008)—for example, observing or manipulating concrete geometrical figures (e.g. triangles) as a basis for abstracting and generalising geometrical properties (Davydov, 1972/1990; Piaget, 1969/1977), a method still influential today (Boonstra et al., 2023; Gal & Linchevski, 2010). Analyses of school textbooks show that this empiricist reliance on concrete visual images remains dominant in primary education, with abstract visual representations gradually taking precedence as school years progress (Alper et al., 2017; Dimopoulos et al., 2003; Guo et al., 2018).

In summary, empiricist assumptions have significantly influenced several established curricular elements, whether through historical inertia, implicit educational goals associated with these assumptions (e.g. nineteenth-century utilitarian curricular goals), or widely held beliefs (e.g. the popular notion of a concrete-to-abstract progression in children's learning).

Effects on student learning: Limitations of empiricist-informed education

The influence of empiricist assumptions on education pioneered recognition of the need to consider students' existing knowledge to support their understanding of academic concepts, in contrast to the excessively abstract oral teaching inherited from the scholastic tradition (Phillips, 2003; Pinar, 2014).

Moreover, empiricist-informed approaches can be effective for learning academic concepts that can be relatively easily connected to students' prior knowledge through progressive abstraction and generalisation—for example, by starting with concrete instantiations that are progressively faded into more abstract ones (Davydov, 1972/1990; Fyfe et al., 2014). For instance, children can improve their understanding of equivalence problems by progressing from using toy bears on balance scales, to worksheets with pictorial representations, and finally to symbolic equations (e.g. $3+4=3+$ __), gradually reducing perceptual detail while preserving the referent relationship (Fyfe et al., 2015).

However, recurring difficulties in understanding and mastery often arise when instruction relies primarily on students' prior, familiar reasoning and everyday experiences—particularly for novice learners and children (Chinn & Brewer, 1993; Davydov, 1972/1990; Karpov, 2003; Kirschner et al., 2006; Land, 2000). These include drawing misleading inferences from familiar preinstructional knowledge or everyday reasoning—particularly when relying on intuitive understandings, perceptual experiences, or concrete knowledge that diverge from the logic of certain academic concepts, especially in science and mathematics (Chinn & Brewer, 1993; Land, 2000; McComas, 2020). For example, children may misinterpret concrete visual features as essential properties (DeLoache, 2000; Land, 2000; Menendez et al., 2020)—such as assuming that concrete visual features of specific instantiations of geometrical figures (e.g. concrete triangles) define their geometric properties (e.g. the properties of triangularity) (Gal & Linchevski, 2010). Another example is learning numbers through the empiricist progression that begins with concrete arithmetic: children often develop the misconception of numbers as discrete entities with fixed successors (Kilpatrick et al., 1975; Vosniadou et al., 2007).

A multi-level analysis of developmental education (DE) and its contrast with empiricist-informed educational approaches

Developmental education (DE) epistemological assumptions, pedagogical principles, and instructional methods were explicitly developed in opposition to empiricist-informed educational approaches, aiming in part to overcome the aforementioned learning limitations (Davydov, 1972/1990; Gal'perin, 1978/1992; Kozulin et al., 2003). As DE remains relatively unknown in educational sciences—especially compared to empiricist-informed approaches—this paper presents it more extensively.[4]

DE or '(Neo-)Vygotskian' approaches were developed by direct collaborators and followers of Vygotsky (1934/1987) to pursue his research on how learning can promote development, especially by fostering children's conceptual development through learning academic (or 'scientific') concepts (Karpov, 2003; Pinar, 2014). DE approaches are diverse; here I focus on the versions initiated by Davydov (1972/1990, 1988/2012) and Gal'perin (1957/1989b, 1978/1992), and pursued by their respective followers (see, e.g. Engeness, 2021; Gennen, 2023; Karpov & Kozulin, 2018; Kozulin et al., 2003).

DE epistemological assumptions

A central aim of DE is to develop in school-age children the tendency to reason based on fundamental academic concepts and the reasoning these concepts require (Davydov, 1972/1990; Karpov, 2003). DE founders opposed the empiricist epistemological assumption that knowledge is acquired by abstraction and generalisation from concrete experience, with types of knowledge differing only in degrees of abstraction, generalisation, and associative mental operations (Davydov, 1972/1990; Ilyenkov, 1960/1982; Karpov, 2003). Everyday knowledge, especially concrete everyday knowledge, fundamentally differs from academic knowledge and its corresponding reasoning and can hinder their acquisition (Davydov, 1972/1990; Gal'perin, 1969/1989a; Karpov, 2003). The first often involves superficial, concrete features and loosely defined categories; the latter involves systematic reasoning about essential and interconnected abstract features.

DE was elaborated, in part, based on the dialectical–materialist theory of knowledge, particularly drawing on Hegel and Marx (Bakhurst, 2023). This epistemology assumes that academic knowledge is specific in being acquired through an analysis of phenomena or objects that reveals the objective interrelations among their essential aspects, thereby allowing theoretical explanations of the origin and functioning of phenomena or objects within a given subject area or problem field (Davydov, 1972/1990; Ilyenkov, 1960/1982). For example, one can theoretically explain the diversity of biological phenomena with the concept of life understood in terms of the essential relationship between an organism and its environment (Ilyenkov, 1960/1982).

Moreover, the dialectical–materialist epistemology considers that abstractions in academic knowledge are not formally detached from particular instantiations, as in empiricist epistemology, but are simultaneously instantiated in them (Bakhurst, 2023; Davydov, 1972/1990; Ilyenkov, 1960/1982). For example, commodity exchange is the most fundamental interrelation at the basis of capitalism, because it generates all its general aspects (from capitalist labour relations to profit generation), yet it is an abstraction that manifests daily in numerous particular instantiations (Ilyenkov, 1960/1982). Specifically, the dialectical–materialist epistemology seeks to understand the interconnections (or dialectical relationships) between particular phenomena and the general conceptual interrelations they instantiate, including dynamic developments of these interconnections (Bakhurst, 2023; Davydov, 1972/1990; Ilyenkov, 1960/1982; Waermö, 2026).

DE educational epistemological assumptions

One main educational epistemological assumption derived from these epistemological assumptions is that students should learn academic knowledge by being familiarised with the most abstract and fundamental conceptual interrelations and corresponding theoretical thinking of academic knowledge, in explicit contrast to empiricist educational epistemological assumptions (Davydov, 1972/1990; Gal'perin, 1969/1989a, 1978/1992).

DE pedagogical principles and instructional methods: 'from the abstract to the concrete'

One key pedagogical principle associated with this educational epistemological assumption is to initiate such learning from the beginning of primary education, and at the start of lessons. Thus, DE opposes the empiricist pedagogical principle that students should begin with concrete learning in early grades and address in upper grades the most abstract, unfamiliar, and theoretical fundamentals of academic knowledge.

Another key DE pedagogical principle, derived from these educational epistemological assumptions (especially the dialectical–materialist view of academic abstractions), is to engage students in learning tasks that make them analyse particular situations and problems in ways that (a) focus their attention on the targeted set of fundamental conceptual interrelations and (b) engage them in reasoning that develops the corresponding theoretical thinking (Davydov, 1972/1990; Gal'perin, 1969/1989a, 1978/1992).

To this purpose, two methods favoured are (a) visual aids modelling the key conceptual interrelations and (b) systematically varying the types of representation of those conceptual interrelations (Davydov, 1972/1990; Gal'perin, 1978/1992).

Thus, students are familiarised from the start with the most general and abstract conceptual interrelations and theoretical thinking, developing an understanding of the diversity of forms and concrete instantiations that arise from these interrelations—learning 'from the abstract to the concrete' (Davydov, 1972/1990).

However, instruction must start from students' existing knowledge. Accordingly, learning tasks are designed to activate selected aspects of prior knowledge useful for learning new academic knowledge, while also fostering an understanding that their prior knowledge is limited and can be misleading. For example, students are confronted with knowledge or reasoning they are expected to rely on, but that proves inadequate—for instance, by encountering an unexpected aspect of a familiar phenomenon—before engaging them in the appropriate reasoning (Davydov, 1972/1990; Gal'perin, 1978/1992; Giest & Lompscher, 2003).

Examples of DE curricula

Mathematics curriculum

DE mathematics curricula differ from the common empiricist progression from concrete arithmetic and natural numbers to abstract algebra and rational numbers. Instead, children are familiarised from the start of primary education with the fundamental interrelation between a quantity and a unit of measurement, forming the basis of all numbers (encapsulated in the concept of real number), and with the logic of algebraic equations (Kilpatrick et al., 1975; Venenciano et al., 2021).

For instance, six-year-old students begin by comparing objects to learn that different quantitative properties (masses, lengths, or volumes) can be measured differently. They learn various methods for representing relationships between the quantitative properties of two objects, such as assigning labels A and B to the lengths of the objects and representing them with paper strips; then, drawn segments; and finally, symbolic representations (e.g. $A > B$).

Next, students face challenges comparing quantities that cannot be directly compared, such as two bookcases located apart or quantities not accurately assessed by sight, such as water in two containers. This problem renders their familiar reasoning about quantities ineffective, prompting the need for a unit of measurement. They learn to 'see a thing as a set of "the number of times a measurement was applied"' (Gal'perin, 1969/1989a, p. 35) to understand that a unit represents an abstraction, something equal to its own measure, and that a number denotes a quantity expressed by a unit of measurement (e.g. 2 signifies something equal to two measures).

Afterwards, they learn to use x as the symbol for an unknown quantity, moving from inequality to equality in formal equations (Kilpatrick et al., 1975). Finally, students are taught a formula that visually models the most fundamental conceptual interrelation behind the concept of a real number: '$A/C = N$, where N is any number, A is any object represented as a quantity, and C is any measure' (Davydov, 1972/1990, p. 169).

Grammar curriculum

As another example, DE language learning curricula do not prioritise first mastering practical classification of nouns, verbs, and adjectives, followed by the study of underlying morphological and syntactic abstractions, as in empiricist-informed curricula. Nor is grammar taught through analogy with everyday and concrete meanings, such as describing the grammatical subject as actively doing something to a passive object.

Instead, students are familiarised from the start of primary education with the most fundamental, abstract, and general conceptual interrelations of grammatical phenomena: the relationship between a morpheme and a meaning communicated (Aidarova, 1982; Davydov, 1972/1990; Gal'perin, 1969/1989a).

For instance, second-grade lessons included:

> [1] The teacher pronounces a word ("kniga [book]," for example), and asks the children what it communicates. […]
> [2] Then the teacher changes the original form of the word "kniga-knigi [book-books]" and asks the children to compare these words and ascertain what each word communicates. The children single out the significance of number and the formal difference (—a -—i) with which it is linked. […]
> [3] By working with other words, the children learned to change and compare them in order to detect formal and semantic differences, and then to represent morphemes in the form of graphic schemes.
> [4] At the next stage particular morphemes were removed from these schemes – and a pure model of the word remained, reflecting only the sequence of its morphemes and the general significance of each of them. (Davydov, 1972/1990, p. 165).

Through familiarisation with the general relationship between morpheme and meaning, students learned the grammatical characteristics of nouns, verbs, and adjectives as distinct communication systems with their specific morphemic forms (Aidarova, 1982; Davydov, 1972/1990; Gal'perin, 1969/1989a).

Effects on student learning: Mitigation of recurrent learning difficulties in empiricist-informed education

Evidence shows that DE reduces the risk of erroneous inferences, confused understandings, or misconceptions caused by interferences from students' prior knowledge, common in empiricist-informed approaches (for general reviews, see: Arievitch & Stetsenko, 2000; Davydov, 1988/2012; Karpov & Haywood, 1998).

For example, conventional empiricist-informed mathematics instruction, progressing from arithmetic and natural numbers to algebra and rational numbers, often reinforces the misconception of numbers as discrete entities with fixed successors, developed early when counting concrete objects in everyday life (Kilpatrick et al., 1975; Vosniadou et al., 2007). Consequently, students often struggle when learning counterintuitive properties of numbers and their continuous nature (e.g. decimals, negative numbers, fractions) or algebra, because of its abstract symbols and formulas.

DE mathematics curricula have been shown to prevent this misconception, familiarising students from the start with the most abstract and fundamental conceptual interrelations underlying all numbers and with the logic of algebraic equations (Karpov, 1995; Kilpatrick et al., 1975; Venenciano et al., 2021). Six-year-old students were also found to overcome the common tendency to focus on perceptually salient features when evaluating quantities (Arievitch & Stetsenko, 2000; Karpov, 1995; Kilpatrick et al., 1975). Instead, students developed an early understanding of the mathematical properties of numbers and algebraic reasoning.

Similarly, students learning grammar can develop unstable, incomplete, or inconsistent mastery of grammatical reasoning due to interference from everyday knowledge (Berry, 2015; Myhill, 2000; Myhill et al., 2012). For instance, third graders assumed that 'warden' and 'wardrobe' are unrelated because one is a person and the other a thing, or that 'mother', 'son', and 'father' are related (Davydov, 1972/1990). These difficulties are especially pronounced in empiricist-informed grammar curricula, which first teach perceptible features of linguistic constructions and later emphasise their underlying morphological and syntactic logics, building on this prior elementary learning (Aidarova, 1982; Davydov, 1972/1990). These difficulties are further amplified when grammatical concepts are taught by analogy with everyday concrete meanings, for instance, describing the subject as someone actively doing something to a passive object, which can lead to confusion between these distinct meanings (Berry, 2015; Davydov, 1972/1990; Myhill, 2000; Myhill et al., 2012).

In contrast, DE curricula familiarise students from the start with grammatical reasoning and abstractions, and their difference from everyday and concrete reasoning, significantly mitigating these difficulties (Aidarova, 1982; Davydov, 1972/1990; Gal'perin, 1978/1992). More generally, DE students attained mastery of abstract academic fundamentals earlier than in conventional education, as they learned them earlier in the curriculum (Davydov, 1988/2012; Kozulin et al., 2003; Venenciano et al., 2021).

Table 1 synthesises the multi-level comparative analysis of empiricist-informed and DE educational approaches.

Discussion

Further illustrations of the multi-level framework for contemporary curriculum analysis

The diagnostic power, empirical applicability, and relevance of this framework extend beyond explicitly contrasted curricula. It applies both to situations where apparently similar curricular suggestions or elements conceal profound divergences and to situations where dissonances appear between levels—with different impacts on student learning—that the framework can reveal and map, as briefly illustrated below with several contemporary curriculum issues.

Inquiry learning has been increasingly promoted in science education curricula (Kridel, 2010; McComas, 2020; Zhang et al., 2022). However, its application can heavily depend on underlying pedagogical principles and epistemological and educational assumptions. Following explicit instruction theory, students can be primarily considered novice learners who often lack the prior knowledge and skills required to interpret new academic content (epistemological assumptions) and should therefore first be explicitly taught key information before inquiring on their own (educational epistemological assumptions). Corresponding pedagogical principles call for strong initial guidance that progressively fades toward more autonomous inquiry for consolidating and deepening learning, privileging methods such as worked examples. Conversely, following constructivist pedagogies, students can be primarily considered active learners who make sense of new knowledge by actively constructing it (epistemological assumptions) and should therefore learn through inquiry- or problem-based learning (educational epistemological assumptions). Pedagogical principles call for having students first inquire or solve problems, with explicit explanations sometimes provided

Table 1. Main epistemological assumptions, educational epistemological assumptions, pedagogical principles, and instructional methods of empiricist-informed educational approaches and developmental education approaches.

Educational approaches	Epistemological assumptions	Educational epistemological assumptions	Pedagogical principles	Instructional methods	Examples
Empiricist	Knowledge is acquired by abstraction and generalisation from concrete knowledge. Types of knowledge, whether everyday or academic, differ only in degrees of abstraction and generalisation of concrete knowledge and types of mental associations between concepts. Academic concepts are general formal categories abstracted from the particular instantiations they refer to.	Students should directly rely on and build upon their existing knowledge, experiences, and reasoning—especially those familiar to them and grounded in their everyday life—to abstract and generalise features of academic knowledge.	Make students directly build upon their existing—especially everyday—experiences or knowledge, and abstract on this basis academic knowledge. Progress from more concrete learning in early grades to learning the more abstract, unfamiliar, and theoretical fundamentals of academic knowledge in upper grades, based on this prior elementary learning.	Direct perceptual experiences. Direct observation as a basis for inferences. Concrete visual images.	Learn numbers by abstracting and generalising them based on counting perceptible objects in arithmetic.
Developmental education	Everyday knowledge is acquired by abstraction and generalisation from concrete knowledge. Academic knowledge is acquired through analyses of phenomena or objects that reveal the abstract interconnections among their essential aspects. Academic knowledge involves essential relationships and precise concepts; everyday knowledge, superficial features and loose categories. Academic concepts refer to a set of abstract conceptual interrelations that are simultaneously instantiated in particular phenomena or objects.	Students should be introduced from the outset to the most abstract and fundamental conceptual interrelations of academic knowledge and its corresponding theoretical thinking.	Engage students in analyses of situations that focus their attention on the most abstract and fundamental conceptual interrelations and develop the corresponding theoretical thinking. From the beginning of primary education, introduce students to the theoretical and abstract fundamentals of academic knowledge and their divergence from everyday knowledge.	Visual models of the key conceptual interrelations. Systematic variation of the types of representation of the key conceptual interrelations.	Learn numbers by familiarising students with the most abstract and fundamental interrelations at their origin: the relationship between quantities and units of measurement.

afterwards, privileging methods such as hands-on exploration and student-led investigations.

The distinct impacts of curricula more informed by one approach or the other on student learning have been the subject of ongoing, vivid debates (de Jong et al., 2024; Zhang et al., 2022). Dissonances can arise in both cases in terms of intended learning effects, with risks of rote or inert learning when explicit instruction dominates and risks of students' misconstructions of knowledge or cognitive overload when constructivist pedagogies are applied.

Collaborative learning has gained increased prominence in curricula and policy discourse (OECD, 2018). It can be promoted based on social constructivist educational epistemological assumptions and corresponding pedagogical principles according to which students should learn through interaction and cooperation, thereby co-constructing knowledge (Palincsar, 1998). However, dissonances can arise between these assumptions and principles, on the one hand, and the methods applied and resulting effects on learning, on the other. Collaborative learning may lead to situations where some peers dominate while others remain passive, work proceeds in parallel without meaningful interaction, or tasks are simply divided among participants (Chi, 2021), or where the cognitive costs of communication and coordination among learners are so high (Janssen & Kirschner, 2020) that learning is impaired compared to individual learning.

Alternatively, collaborative learning can be promoted based on epistemological and educational assumptions such as those of the ICAP learning theory, according to which it can be a powerful catalyst for learning, but only if the underlying pedagogical principles and corresponding methods ensure that collaboration is designed so that each learner generates new inferences extending beyond their own knowledge and that of peers, thus fostering genuine co-construction of knowledge (Chi, 2021).

AI-based instruction's increasing prominence in curricula is another example highlighting the crucial need for the multi-level framework. Evidence on AI-based instruction's impact on student learning is mixed (Létourneau et al., 2025), and its adoption may carry implicit yet potentially problematic assumptions about education, along with ethical concerns (Holmes & Tuomi, 2022). This underscores the need to examine the underlying epistemological assumptions and corresponding pedagogical principles that explicitly or implicitly justify and guide their implementation. Technologically innovative instructional methods have often come with exaggerated claims to revolutionise education (Holmes & Tuomi, 2022), while many curricular policies push for 'methods that work' (Biesta, 2015). Both tendencies risk neglecting the educational assumptions and principles they presuppose, implicitly or explicitly, along with the curricular and educational issues they entail—precisely the kinds of hidden chains of influence that the multi-level framework is particularly suited to reveal.

Dissonances can arise between, on the one hand, epistemological and educational assumptions and corresponding pedagogical principles that assume AI tools, due to their instantaneous and individually tailored feedback, foster active, autonomous, and personalised self-learning, and, on the other hand, how they are actually implemented and the resulting impacts on learning. Indeed, AI-based instructional methods may instead tend to foster over-reliance on AI outputs, excessive cognitive off-loading, and passive engagement.

Implications for curriculum research

Curriculum studies are divided between competing broad theories of curricula (Pratt, 2022; Schiro, 2013). This framework offers a theory-transversal analytical tool that enables a close-grained analysis of curricula, examining how they have been constituted through chains linking epistemological assumptions, pedagogical principles, and instructional applications. In doing so, it directly contributes to a central aim of critical curriculum studies: better understanding how the past shapes the present and future (Pinar et al., 2008). Specifically, it shows how certain (disputable) epistemological assumptions have persisted, evolved, and continued to shape curricula in renewed forms, with potentially problematic implications for education.

Decolonial (e.g. Moncrieffe, 2022), feminist (e.g. Miller, 2005), and critical pedagogy curriculum analyses (e.g. Giroux & Penna, 1979) have also aimed to uncover implicit or taken-for-granted epistemological assumptions shaping curricula and educational practices, often emphasising their political implications. In particular, decolonial, Indigenous, and anthropological research on curriculum has examined how dominant epistemological assumptions may produce forms of epistemic domination that marginalise alternative ways of knowing and corresponding educational forms. The present analysis can complement such work: first, by providing a systematic framework for tracing the influence of epistemological assumptions across key levels of educational theory and curricula; second, by bringing into dialogue fields that rarely interact and are often treated as antagonistic: historical and critical curriculum analysis, epistemology, and the learning and cognitive sciences.

Conclusion

Epistemological assumptions profoundly, yet indirectly and implicitly, shape curricula and, through them, education. However, detailed tracing of their effects down to specific impacts on student learning remains rare. This paper introduced a multi-level analytical framework that systematically traces these influences across key interrelated levels: from epistemological assumptions to educational epistemological assumptions, pedagogical principles, instructional methods, and their impacts on student learning.

The multi-level comparative analysis of empiricist-informed and developmental education approaches demonstrated that distinct epistemological assumptions can lead to markedly different implications for curriculum design, pedagogy, and student learning. By revealing the epistemological foundations of curricula and their influence on education, this multi-level framework supports critical curriculum studies, fosters the exploration of alternative curricula, and provides a tool to rethink educational theory and practice.

Notes

1. There is no claim that epistemological assumptions are the only influence on learning theories and curricula, or that education is limited to learning knowledge.
2. Academic knowledge refers to subject-matter content that is taught and learned within educational institutions such as schools and universities.

3. Instruction is understood broadly as any educational approach intended to impart knowledge or skills to students.
4. The asymmetry between the abundance of references in curriculum research to empiricist-informed curricula cited here and the comparatively limited number of references to developmental education reflects the latter's underrepresentation in curriculum research.

Ethical approval

No ethical approval was required for the preparation of the manuscript, as no human or animal subjects were involved.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Thomas Gennen holds a Ph.D. in Educational Sciences and two master's degrees in Philosophy and Anthropology from the Free University of Brussels (ULB). He is a postdoctoral researcher in the learning sciences at the Berkeley School of Education, University of California, Berkeley, and a research fellow at the Center for Affective Neuroscience, Development, Learning, and Education (CANDLE) at the Rossier School of Education, University of Southern California. His research examines competing educational theories and approaches in key contemporary debates, including the instructivist–constructivist debate, divisions in conceptual change research, and debates on the influence of teachers' epistemological beliefs on classroom practices (which he has also examined through long-term ethnographic fieldwork in Waldorf schools, used as an extended case study). He develops a multi-level analytical framework tracing how epistemological assumptions influence educational theories, instructional approaches, and student learning processes. He is first author of publications in leading journals, including *Educational Review*, *Human Development*, and *Educational Philosophy and Theory*. His research has received awards, including from the American Educational Research Association (AERA), the European Association for Research on Learning and Instruction (EARLI), the Jean Piaget Society, and the Belgian American Educational Foundation. His work includes a published commentary-and-response exchange with Andrea diSessa, reflecting engagement with leading scholarship in educational sciences and educational theory.

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References

Aidarova, L. (1982). *Child development and education* (L. Lezhneva, Trans.). Progress.
Alper, B., Riche, N. H., Chevalier, F., Boy, J., & Sezgin, M. (2017, May). Visualization literacy at elementary school. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (pp. 5485–5497). Association for Computing Machinery.
Arievitch, I. M., & Stetsenko, A. (2000). The quality of cultural tools and cognitive development: Gal'perin's perspective and its implications. *Human Development*, *43*(2), 69–92. https://doi.org/10.1159/000022661

Bakhurst, D. (2023). *The heart of the matter: Ilyenkov, Vygotsky and the courage of thought*. Brill.
Berry, R. (2015). Grammar myths. *Language Awareness*, *24*(1), 15–37. https://doi.org/10.1080/09658416.2013.873803
Biesta, G. J. (2015). *Good education in an age of measurement: Ethics, politics, democracy*. Routledge.
Boonstra, K., Kool, M., Shvarts, A., & Drijvers, P. (2023). Theories and practical perspectives on fostering embodied abstraction in primary school geometry education. *Frontiers in Education*, *8*. https://doi.org/10.3389/feduc.2023.1162681
Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.
Bruner, J. (1977). *The process of education*. Harvard University Press. (Original work published 1960).
Bruner, J. (1985). Models of the learner. *Educational Horizons*, *64*(4), 197–200.
Chi, M. T. H. (2021). Translating a theory of active learning: An attempt to close the research-practice gap in education. *Topics in Cognitive Science*, *13*(3), 441–463. https://doi.org/10.1111/tops.12539
Chinn, C. A., & Brewer, W. F. (1993). The role of anomalous data in knowledge acquisition: A theoretical framework and implications for science instruction. *Review of Educational Research*, *63*(1), 1–49. https://doi.org/10.3102/00346543063001001
Davydov, V. V. (1964). On changing the content of primary school instruction. *Soviet Education*, *7*(1), 27–35. https://doi.org/10.2753/RES1060-9393070127
Davydov, V. V. (1990). *Types of generalization in instruction: Logical and psychological problems in the structuring of school curricula* (J. Teller, Trans.). Soviet Studies in Mathematics Education: Volume 2. National Council of Teachers of Mathematics. (Original work published 1972).
Davydov, V. V. (2012). *Problems of developmental instruction: A theoretical and experimental psychological study* (P. Moxhay, Trans.). Nova Science Publishers. (Original work published 1988).
de Jong, T., Lazonder, A. W., Chinn, C. A., Fischer, F., Gobert, J., Hmelo-Silver, C. E., Koedinger, K. R., Krajcik, J. S., Kyza, E. A., Linn, M. C., Pedaste, M., Scheiter, K., & Zacharia, Z. C. (2024). Beyond inquiry or direct instruction: Pressing issues for designing impactful science learning opportunities. *Educational Research Review*, *44*, 100623. https://doi.org/10.1016/j.edurev.2024.100623
DeLoache, J. S. (2000). Dual representation and young children's use of scale models. *Child Development*, *71*(2), 329–338. https://doi.org/10.1111/1467-8624.00148
Dimopoulos, K., Koulaidis, V., & Sklaveniti, S. (2003). Towards an analysis of visual images in school science textbooks and press articles about science and technology. *Research in Science Education*, *33*(2), 189–216. https://doi.org/10.1023/A:1025006310503
El'konin, D. (1999). On the theory of primary education. *Soviet Education*, *37*(6), 71–83. https://doi.org/10.2753/RPO1061-0405370671 (Original work published 1963).
Engeness, I. (2021). *P. Y. Galperin's development of human mental activity: Lectures in educational psychology*. Springer.
Fodor, J., & Pylyshyn, Z. (2015). *Minds without meanings: An essay on the content of concepts*. The MIT Press.
Foucault, M. (2001). Nietzsche, genealogy, history. In J. Richardson & B. Leiter (Eds.), *Nietzsche* (pp. 139–164). Oxford University Press. (Original work published 1971).
Fyfe, E. R., McNeil, N. M., & Borjas, S. (2015). Benefits of "concreteness fading" for children's mathematics understanding. *Learning and Instruction*, *35*, 104–120. https://doi.org/10.1016/j.learninstruc.2014.10.004
Fyfe, E. R., McNeil, N. M., Son, J. Y., & Goldstone, R. L. (2014). Concreteness fading in mathematics and science instruction: A systematic review. *Educational Psychology Review*, *26*(1), 9–25. https://doi.org/10.1007/s10648-014-9249-3
Gal, H., & Linchevski, L. (2010). To see or not to see: Analyzing difficulties in geometry from the perspective of visual perception. *Educational Studies in Mathematics*, *74*(2), 163–183. https://doi.org/10.1007/s10649-010-9232-y
Gal'perin, P. Ya. (1989a). Study of the intellectual development of the child. *Soviet Psychology*, *27*(3), 26–44. https://doi.org/10.2753/RPO1061-0405270326 (Original work published 1969).

Gal'perin, P. Ya. (1989b). Mental actions as a basis for the formation of thoughts and images. *Soviet Psychology*, *27*(3), 45–64. https://doi.org/10.2753/RPO1061-0405270345 (Original work published 1957).

Gal'perin, P. Ya. (1992). Stage-by-stage formation as a method of psychological investigation. *Journal of Russian & East European Psychology*, *30*(4), 60–80. https://doi.org/10.2753/RPO1061-0405300460 (Original work published 1978).

Gattegno, C. (1984). Curriculum and epistemology. *For the Learning of Mathematics*, *4*(2), 33–38.

Gennen, T. (2023). Conceptual change and education: The neglected potential of developmental teaching approaches. *Human Development*, 67(2), 88–107. https://doi.org/10.1159/000530247

Gennen, T. (2025). Reevaluating student-centred education: Uncovering learning difficulties stemming from empiricist epistemological assumptions. *Educational Review*, 77(3), 894–920. https://doi.org/10.1080/00131911.2024.2409949

Gennen, T. (2026). Faire la généalogie des présupposés épistémologiques des approches pédagogiques : Le cas problématique des pédagogies constructivistes. In O. Gilon & C. Tresnie (Coord.), *Histoire de la philosophie et éducation*. Librairie philosophique J. Vrin.

Giest, H., & Lompscher, J. (2003). Formation of learning activity and theoretical thinking in science teaching. In A. Kozulin, B. Gindis, V. S. Ageyev, & S. M. Miller (Eds.), *Vygotsky's educational theory in cultural context* (pp. 267–288). Cambridge University Press. https://doi.org/10.1017/CBO9780511840975.015

Giroux, H. A., & Penna, A. N. (1979). Social education in the classroom: The dynamics of the hidden curriculum. *Theory & Research in Social Education*, *7*(1), 21–42. https://doi.org/10.1080/00933104.1979.10506048

Glover, J. A., & Ronning, R. R. (Eds.). (1987). *Historical foundations of educational psychology*. Springer US. https://doi.org/10.1007/978-1-4899-3620-2

Guo, D., Wright, K. L., & McTigue, E. M. (2018). A content analysis of visuals in elementary school textbooks. *The Elementary School Journal*, *119*(2), 244–269. https://doi.org/10.1086/700266

Hirst, P. H. (2010). *Knowledge and the curriculum: A collection of philosophical papers*. Routledge & Kegan Paul. (Original work published 1974).

Holmes, W., & Tuomi, I. (2022). State of the art and practice in AI in education. *European Journal of Education*, *57*(4), 542–570. https://doi.org/10.1111/ejed.12533

Howlett, J. (2014). *Progressive education: A critical introduction*. Bloomsbury.

Ilyenkov, E. (1982). *The dialectics of the abstract & the concrete in Marx's Capital* (S. Kuzyakov, Trans.). Progress Publishers. (Original work published 1960).

Jacobson, M. J., Levin, J. A., & Kapur, M. (2019). Education as a complex system: Conceptual and methodological implications. *Educational Researcher*, *48*(2), 112–119. https://doi.org/10.3102/0013189X19826958

Janssen, J., & Kirschner, P. A. (2020). Applying collaborative cognitive load theory to computer-supported collaborative learning: Towards a research agenda. *Educational Technology Research and Development*, *68*(2), 783–805. https://doi.org/10.1007/s11423-019-09729-5

Karpov, Y. V. (1995). L. S. Vygotsky as a founder of a new approach to instruction. *School Psychology International*, *16*(2), 131–142. https://doi.org/10.1177/0143034395162004

Karpov, Y. V. (2003). Vygotsky's doctrine of scientific concepts: Its role for contemporary education. In A. Kozulin, B. Gindis, V. S. Ageyev, & S. M. Miller (Eds.), *Vygotsky's educational theory in cultural context* (pp. 65–82). Cambridge University Press.

Karpov, Y. V., & Haywood, H. C. (1998). Two ways to elaborate Vygotsky's concept of mediation. *American Psychologist*, *53*(1), 27–36. https://doi.org/10.1037/0003-066X.53.1.27

Karpov, Y. V., & Kozulin, A. (Eds.). (2018). The Vygotskian approach to teaching: Practical applications around the globe [Special issue]. *Journal of Cognitive Education and Psychology*, *17*(3), 217–300. https://doi.org/10.1891/1945-8959.17.3.219

Kilpatrick, J., Steffe, L. P., Clarkson, S. P., Kantowski, M. G., & Wilson, J. W. (Eds.). (1975). *Soviet studies in the psychology of learning and teaching mathematics, volume VII: Children's capacity for learning mathematics*. School Mathematics Study Group & Survey of Recent East European Mathematical Literature.

Kirby, J. R., & Bowers, P. N. (2017). Morphological instruction and literacy: Binding phonological, orthographic, and semantic features of words. In K. Cain, D. L. Compton, & R. K. Parrila (Eds.), *Studies in written language and literacy* (Vol. 15, pp. 437–462). John Benjamins Publishing Company. https://doi.org/10.1075/swll.15.24kir

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, *41*(2), 75–86. https://doi.org/10.1207/s15326985ep4102_1

Kozulin, A., Gindis, B., Ageyev, V. S., & Miller, S. M. (Eds.). (2003). *Vygotsky's educational theory in cultural context*. Cambridge University Press.

Kridel, C. A. (Ed.). (2010). *Encyclopedia of curriculum studies*. SAGE Publications.

Land, S. M. (2000). Cognitive requirements for learning with open-ended learning environments. *Educational Technology Research and Development*, *48*(3), 61–78. https://doi.org/10.1007/BF02319858

Létourneau, A., Deslandes Martineau, M., Charland, P., Karran, J. A., Boasen, J., & Léger, P. M. (2025). A systematic review of AI-driven intelligent tutoring systems (ITS) in K-12 education. *NPJ Science of Learning*, *10*(1), 29. https://doi.org/10.1038/s41539-025-00320-7

Locke, J. (1975). *An essay concerning human understanding*. Oxford University Press. (Original work published 1690).

Margolis, E., & Laurence, S. (Eds.). (1999). *Concepts: Core readings*. MIT Press.

Matthews, M. R. (2014). Pendulum motion: A case study in how history and philosophy can contribute to science education. In M. R. Matthews (Ed.), *International handbook of research in history, philosophy and science teaching* (pp. 19–56). Springer Netherlands. https://doi.org/10.1007/978-94-007-7654-8_2

McComas, W. F. (Ed.). (2020). Nature of science in science instruction: Rationales and strategies. Springer International Publishing. https://doi.org/10.1007/978-3-030-57239-6

Menendez, D., Rosengren, K. S., & Alibali, M. W. (2020). Do details bug you? Effects of perceptual richness in learning about biological change. *Applied Cognitive Psychology*, *34*(5), 1101–1117. https://doi.org/10.1002/acp.3698

Miller, J. L. (2005). *Sounds of silence breaking: Women, autobiography, curriculum*. Peter Lang.

Mills, K. A., & Unsworth, L. (2016). The literacy curriculum: A critical review. In D. Wyse, L. Hayward, & J. Pandya, (Eds.), *The SAGE handbook of curriculum, pedagogy and assessment: Two volume set* (pp. 621–637). SAGE Publications. https://doi.org/10.4135/9781473921405.n39

Moncrieffe, M. L. (Ed.). (2022). *Decolonising curriculum knowledge: International perspectives and interdisciplinary approaches*. Springer. https://doi.org/10.1007/978-3-031-13623-8

Montessori, M. (2012). *The Montessori method.* Renaissance Classics. (Original work published 1912).

Myhill, D. A. (2000). Misconceptions and difficulties in the acquisition of metalinguistic knowledge. *Language and Education*, *14*(3), 151–163. https://doi.org/10.1080/09500780008666787

Myhill, D. A., Jones, S. M., Lines, H., & Watson, A. (2012). Re-thinking grammar: The impact of embedded grammar teaching on students' writing and students' metalinguistic understanding. *Research Papers in Education*, *27*(2), 139–166. https://doi.org/10.1080/02671522.2011.637640

Organisation for Economic Co-operation and Development (OECD). (2018). *The future of education and skills: Education 2030*. OECD.

Palincsar, A. S. (1998). Social constructivist perspectives on teaching and learning. *Annual Review of Psychology*, *49*(1), 345–375. https://doi.org/10.1146/annurev.psych.49.1.345

Phillips, D. C. (2003). Theories of teaching and learning. In R. Curren (Ed.), *A companion to the philosophy of education* (pp. 232–245). Blackwell Publishing Ltd. https://doi.org/10.1002/9780470996454.ch17

Piaget, J. (1977). *Science of education and the psychology of the child*. Penguin Books. (Original work published 1969).

Pinar, W. (Ed.). (2014). *International handbook of curriculum research* (2nd ed.). Routledge.

Pinar, W. F., Reynolds, W. M., Slattery, P., & Taubman, P. M. (2008). *Understanding curriculum: An introduction to the study of historical and contemporary curriculum discourses* (5th ed.). Peter Lang.

Pratt, A. B. (2022). Teaching curriculum theory as a Baradian apparatus. *Educational Philosophy and Theory*, *54*(12), 2029–2042. https://doi.org/10.1080/00131857.2021.1972415

Schiro, M. (2013). *Curriculum theory: Conflicting visions and enduring concerns* (2nd ed.). SAGE Publications.

Schunk, D. H. (2020). *Learning theories: An educational perspective*. Pearson Education.

Schwab, J. J. (1978). *Science, curriculum, and liberal education: Selected essays*. University of Chicago Press.

Scott, D. (2014). Knowledge and the curriculum. *The Curriculum Journal*, *25*(1), 14–28. https://doi.org/10.1080/09585176.2013.876367

Uttal, D. H., Liu, L. L., & DeLoache, J. S. (2006). Concreteness and symbolic development. In L. Balter & C. S. Tamis-LeMonda (Eds.), *Child psychology: A handbook of contemporary issues* (2nd ed., pp. 167–184). Psychology Press.

van Rijt, J., de Swart, P., & Coppen, P.-A. (2019). Linguistic concepts in L1 grammar education: A systematic literature review. *Research Papers in Education*, *34*(5), 621–648. https://doi.org/10.1080/02671522.2018.1493742

Varela, J. (2001). Genealogy of education: Some models of analysis. In T. Popkewitz (Ed.), *Cultural history and education: Critical essays on knowledge and schooling* (pp. 107–124). Routledge.

Venenciano, L., Polotskaia, E., Mellone, M., & Radford, L. (Eds.). (2021). Davydov's approach in the 21st century: Views from multiple perspectives [Special issue]. *Educational Studies in Mathematics*, *106*(3), 323–478.

Vosniadou, S., Baltas, A., & Vamvakoussi, X. (Eds.). (2007). *Reframing the conceptual change approach in learning and instruction*. Elsevier.

Vygotsky, L. S. (1987). Thinking and speech (N. Minick, Trans.). In R. W. Rieber & A. S. Carton (Eds.), *The collected works of L. S. Vygotsky: Vol. 1. Problems of general psychology* (pp. 39–285). Plenum Press. (Original work published 1934).

Waermö, M. (2026). Reframing critical aspects as a didactic tool for instruction oriented toward theoretical thinking. *Scandinavian Journal of Educational Research*, *70*(3), 1–13. https://doi.org/10.1080/00313831.2026.2662231

Walker, J. C., & Evers, C. W. (1982). Epistemology and justifying the curriculum of educational studies. *British Journal of Educational Studies*, *30*(2), 213–229. https://doi.org/10.1080/00071005.1982.9973626

Winch, C. (2013). Curriculum design and epistemic ascent. *Journal of Philosophy of Education*, *47*(1), 128–146. https://doi.org/10.1111/1467-9752.12006

Young, M., & Muller, J. (2013). On the powers of powerful knowledge. *Review of Education*, *1*(3), 229–250. https://doi.org/10.1002/rev3.3017

Zhang, L., Kirschner, P. A., Cobern, W. W., & Sweller, J. (2022). There is an evidence crisis in science educational policy. *Educational Psychology Review*, *34*(2), 1157–1176. https://doi.org/10.1007/s10648-021-09646-1