Received: 12 Nov. 2026 | Revised: 14 Nov. 2026 | Accepted: 16 Nov. 2026 | Published online: 25 Nov. 2026
RESEARCH ARTICLE

Contemporary Education and Teaching Research
2026,Vol. 7(11)415-421
DOI: 10.61360/BoniCETR262021091108

When the Half-Life of Curriculum Is Shorter Than the Program: Rethinking China's '3+4' Pathways in the AI Era

Huan Kong[1], Chang Kong[2,*]

[1]Dongting School, Wuhan ,P.R.China

[2]Shenzhen Polytechnic University,P.R.China

Abstract: China's '3+4' pathways combine three years of secondary vocational education with four years of undergraduate study. Their success depends on more than continuity between educational stages: curriculum renewal must also keep pace with changes in occupational knowledge, tools, and tasks. This conceptual perspective develops curriculum half-life as a domain-specific lens for examining that temporal mismatch. It distinguishes the institutional timescale of program coordination, the industrial timescale of technological change, and the learning timescale of capability development. It argues that front-loaded design, tool-dependent teaching, assessment rigidity, and short-horizon industry participation can reinforce one another, allowing an internally coherent curriculum to lose occupational relevance before graduation. A three-layer architecture links an elastic conceptual core, portable capabilities, and replaceable industry interface modules to differentiated review schedules, version control, and student protection. The framework is illustrated through AI-related education without restricting its implications to a particular city. Four propositions identify how its mechanisms could be tested in future research. No numerical half-life or educational effect is estimated; the contribution is an explicit account of why articulation and renewal must be designed together.

Keywords: curriculum half-life, "3+4" articulated programs, vocational education, curriculum architecture, AI talent cultivation

1. Introduction

China's '3+4' pathways connect three years of secondary vocational education with four years of undergraduate study. They aim to provide coherent progression in knowledge, technical competence, and educational opportunity, rather than merely extend time spent in school. Undergraduate entry remains conditional on progression requirements, whose form varies across jurisdictions. Guangzhou's 2026 guidance, for example, specifies transfer assessment and conditions under which students may leave the pathway (Guangzhou Admissions and Examinations Committee Office, 2026). The educational rationale is that vocational learning can support higher levels of capability without losing its distinctive orientation (Jiang, 2011; Xu, 2018). The aspiration '3+4>7' is consequently a claim about added educational value, not an established outcome of every integrated program.

Research identifies genuine problems in joining the two stages. A review organises the literature around program design, curricula, implementation, evaluation, and institutional support (Chen, 2023). A study of two participating undergraduate institutions reports curriculum discontinuity, unclear assessment emphases, and uneven development alongside strengths in adaptation to student backgrounds (Liu et al., 2020). These findings justify attention to sequencing, prerequisites, and joint evaluation. They do not establish that all pathways share the same defects or that temporal obsolescence caused those difficulties.

This paper argues that articulation alone cannot resolve a structural mismatch between long-cycle education and fast-changing occupational practice. Where credits, staffing, equipment, and transfer assessment are substantially agreed before enrolment, later revision requires coordinated change across institutions. Revision is possible, but its costs can make the initial plan the enduring default. In AI-related education, some tool-specific procedures can lose occupational relevance well before a seven-year cohort graduates. A curriculum can therefore be internally coherent yet insufficiently renewed. The problem is the rigidity of coordinated commitments, rather than a legal prohibition on

Corresponding Author: Chang Kong
Shenzhen Polytechnic University,P.R.China
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redesign.

The seven-year pathway makes this tension consequential because students commit to an educational direction early and encounter several learning stages before graduation. Its length also provides time for conceptual development and repeated application. The question is whether the curriculum can exploit that time while revising content whose relevance changes more quickly. Computing and AI provide a useful focal domain because enduring concepts coexist with frequently changing implementations.

The paper makes three contributions. First, it develops a domain-specific interpretation of curriculum half-life for articulated education. Second, it explains how four temporal failure modes sustain a reinforcing loop under identifiable conditions. Third, it proposes a three-layer architecture with explicit responsibilities for review, replacement, and student protection. This is a conceptual perspective drawing selectively on curriculum scholarship, vocational education research, and public policy materials, not a systematic review or empirical evaluation. Published findings motivate the argument; the mechanisms and proposals are its analytical contribution. Sections 2–5 develop the framework, Section 6 considers implementation across settings, and Sections 7–8 specify testable propositions and limitations.

2. Articulation and the Problem of Curriculum Renewal

Articulation research asks how educational stages can form a coherent pathway. Its concerns include objectives, prerequisites, progression, assessment, and institutional coordination (Chen, 2023). A seven-year plan can, however, be treated either as a revisable framework or as a fixed allocation of responsibilities. The temporal problem emerges in the latter implementation: coherence achieved at approval is taken as adequate assurance of relevance at graduation. This distinction avoids attributing a uniformly static position to a diverse literature.

Three design questions must be separated. Does the curriculum connect successive learning experiences? Are its outcomes appropriate to the occupational and educational purposes of the program? Can those outcomes and their implementations be revised while students are enrolled? Course mapping can answer the first without settling the other two. A plan that reduces duplication may still lack a procedure for recognising that a formerly useful task has lost relevance. Temporal responsiveness must therefore be examined directly rather than inferred from a complete articulation matrix.

Constructive alignment connects intended learning outcomes, teaching activities, and assessment (Biggs & Tang, 2011). It does not require outcomes to remain fixed. The limitation addressed here arises when alignment is implemented through static documents and approval routines. Coherence and currency are distinct, interacting properties: changing an outcome can disturb coherence, while excessive commitment to an established mapping can obstruct renewal. The proposed framework supplements alignment by specifying when and by whom its components should be reconsidered.

Learning for an uncertain future requires more than mastery of a current occupational specification. Barnett (2004) places uncertainty at the centre of educational thinking, while Facer (2011) connects educational futures to technological and social change. These perspectives support cultivating the capacity to interpret unfamiliar situations and continue learning. They do not imply that occupational knowledge can be discarded or that adaptability develops without substantive understanding. The design task is to connect durable knowledge to changing applications.

Boundary-crossing scholarship also offers resources for renewal. Shared documents and joint practices can coordinate learning across settings, and boundary crossing can generate transformation rather than merely preserve existing arrangements (Akkerman & Bakker, 2011). Communities of practice involve learning through participation over time (Wenger, 1998). A joint curriculum board can thus be both an articulation mechanism and a site of revision. The present argument adds explicit temporal responsibilities: monitoring requirements, authorising changes, and maintaining continuity for affected students.

3. Curriculum Half-Life as An Analytical Construct

Curriculum half-life denotes the time after which half of a specified set of curricular elements no longer provides adequate preparation for a defined set of occupational tasks without substantial updating. The unit must be specified: learning outcomes, assessed procedures, and teaching content cannot be counted interchangeably. ‘Half’ refers to a stated counting or weighting rule, not half of all disciplinary knowledge. An estimate would require a baseline date, a target task domain, and a criterion for retained relevance. The construct concerns changing task relevance, rather than students forgetting what they learned.

Three dimensions prevent false equivalence. Content currency concerns concepts, standards, and problems; tool currency concerns platforms and implementations; task currency concerns how work is organised. A software release does not automatically invalidate a concept, and an older tool may remain useful for explanation after its

occupational use declines. Relevance can fall abruptly, remain stable, or recover; no exponential decay law is assumed. This paper estimates none of these trajectories. Its claim is that a mismatch between renewal and changing requirements creates educational risk even when its precise size remains unmeasured.

Three timescales govern an articulated program. The institutional timescale covers the seven-year pathway and its shorter approval, staffing, and assessment cycles. The industrial timescale concerns changes in tools, standards, and tasks. Deming and Noray (2020) provide evidence of changing skill requirements in technology-intensive careers. The duration of curricular relevance nevertheless depends on the specific content and task domain. The learning timescale concerns cumulative practice, abstraction, and transfer, with variation among students and domains. Table 1 distinguishes these timescales and the different design responsibilities they entail.

Table 1. Three timescales and their implications for curriculum renewal

Timescale	Temporal basis	What changes	Design implication
Institutional	Seven-year pathway; nested review cycles	Credits, responsibilities, progression rules	Delegate revision within agreed limits
Industrial	Domain- and task-dependent	Tools, standards, work practices	Use evidence-triggered review
Learning	Cumulative; varies by learner and domain	Depth, practice, abstraction, transfer	Preserve continuity and revisit foundations

The critical comparison is between the pace of relevant change and the time required to recognise and respond to it. A seven-year program need not use seven-year-old materials. Conversely, annual textbook replacement does not establish that assessment or occupational tasks have been updated. If coordinated revision remains slower than substantial change in the target domain, students encounter increasingly outdated requirements despite orderly progression. Learning continuity constrains the response: new content must build on prior understanding rather than repeatedly reset the sequence.

Two implications follow. First, tightly coupled articulation amplifies obsolescence when revisions require cascading approvals and no space or authority is reserved for renewal. Tight coupling is not inherently brittle; coordinated review can also make it a resource for change. Second, '3+4>7' depends on maintaining both progression and relevance. Renewal capacity is necessary to address obsolescence in rapidly changing domains, but not sufficient for educational quality: teaching, resources, assessment, and student support remain essential. Renewal alone cannot guarantee the added value of a seven-year pathway.

Computing and AI make differentiated renewal especially important. Mathematical reasoning, abstraction, and principles of validation can remain useful across tool generations, whereas particular interfaces, libraries, and deployment procedures may need more frequent review. Systems knowledge and engineering practices contain both durable and changing elements. These are design distinctions rather than measured rankings of half-lives. A course can contain elements from all three categories. Classifying their review needs should preserve, rather than dismantle, the coherent learning experience in which they belong.

4. Four Temporal Failure Modes

Four temporal failure modes explain how front-loaded coordination persists after occupational requirements change. They are analytical mechanisms, not prevalence estimates or causal findings established across all '3+4' programs. Together they identify where renewal can be blocked even when institutions recognise the need for closer articulation.

4.1. Frozen foundations

The problem is not that mathematical principles expire whenever a new tool appears. It is that the selection, depth, sequencing, and application of foundations can remain calibrated to an earlier occupational profile. Evaluating AI outputs, diagnosing data problems, and reasoning about uncertainty can change which foundations need emphasis and repeated application. Early course placement and cross-departmental responsibilities make substantial revision costly after a cohort has progressed. Kong et al. (2016) examine guided mathematics learning and learning habits, drawing attention to how foundational learning is organised. Extending that concern to curriculum renewal, temporal failure occurs when changing needs cannot trigger a coordinated response in foundational teaching.

4.2. Tool-locked skills

Autor's (2015) analysis motivates attention to changing task bundles, while Deming and Noray (2020) connect skill change to career dynamics. Extending this perspective to curriculum design, tool dependence arises when teaching rewards procedural fluency without requiring explanation or transfer. Equipment investment, staff familiarity, and established examination tasks create incentives to

retain the same implementation. Repeated practice and conceptual depth can both support competence. The risk emerges when one implementation becomes the enduring object of learning and students have few opportunities to apply their understanding elsewhere.

4.3. Assessment lag

A high-stakes progression requirement preserves an earlier specification of competence when assessment is harder to revise than classroom examples. Teachers rationally prioritise what students must demonstrate to progress, and material outside established assessment receives less attention. Assessment lag is therefore a governance problem as well as a teaching problem. Liu et al. (2020) identify discontinuity and unclear evaluation emphases. These findings motivate closer analysis of how evaluation requirements interact with renewal. The proposed mechanism applies where assessment is tied to particular tools and slow revision procedures. Stable criteria can instead support renewal if they assess durable capabilities through replaceable tasks.

4.4. Enterprise horizon mismatch

Firms may need deployable capabilities sooner than a seven-year pathway can produce graduates. They may also resist committing staff and infrastructure for the full program while their own requirements remain uncertain. These conditions favour short, visible participation over sustained curricular responsibility. They do not imply that all firms have a one-to-three-year planning horizon or that durable partnerships are impossible. The structural issue is the allocation of commitments: cooperation tied only to a distant graduating cohort offers fewer immediate reasons to contribute than recurring, bounded activities with explicit responsibilities and mutual benefits.

4.5. The reinforcing loop

Under rigid approval and weak external feedback, these mechanisms reinforce one another. If foundations are not recontextualised, staff can meet immediate performance demands through familiar procedures. Assessment based on those procedures rewards continued investment in the same tools. External partners then have limited influence over what counts as success, reducing the value of substantive participation. Weaker participation removes an important source of evidence about changing requirements and reinforces reliance on the original plan. This is the proposed feedback structure, not an inevitable sequence: teacher networks, student feedback, professional standards, and empowered review boards can interrupt it. Students bear high adjustment costs when departure entails losing progression arrangements, but they are not universally prohibited from exit. Guangzhou's 2026 guidance permits certain transfers while withdrawing pathway-specific treatment (Guangzhou Admissions and Examinations Committee Office, 2026).

5. A Three-Layer Curriculum Architecture

The response must combine coherent progression with differentiated renewal. The proposed architecture classifies curricular elements by educational function and renewal need while retaining joint institutional responsibility. It does not require separate administrative departments or exclusive assignment of every course to one layer. Figure 1 shows the elastic core and portable capabilities developing across seven years, with industry interface modules reviewed within that shared sequence. The institutional boundary remains visible, but does not determine where foundational learning ends or where renewal begins.

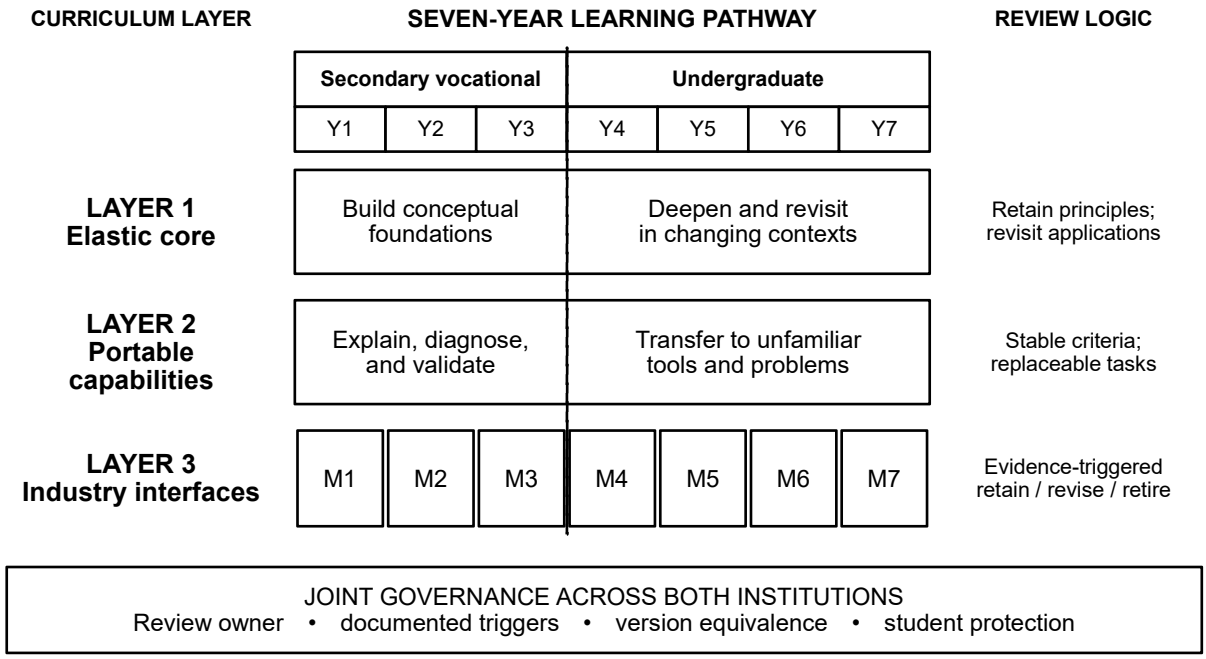

Figure 1. A three-layer architecture for continuous curriculum renewal. The dashed line marks progression after Year 3. Continuous bands represent cumulative learning, not unchanged content. Equal-width module boxes are schematic and do not prescribe annual replacement. Review must respond to evidence while preserving progression and student entitlements.

5.1. Layer one: the elastic core

The core provides concepts that explain unfamiliar implementations: abstraction, probabilistic reasoning, principles of computation, correctness, resource constraints, and evidence-based validation. 'Elastic' means revisiting concepts at greater depth and applying them to new contexts, rather than completing them once as prerequisites. Ethical reasoning, data responsibility, and human judgement also need sustained development. The UNESCO framework connects AI learning with human-centred and ethical concerns (Miao et al., 2024). Foundational review should distinguish changing applications from changes to concepts. Removing topics solely because their immediate labour-market visibility declines would undermine the core's longer-term purpose.

5.2. Layer two: portable capabilities

This layer concerns applying knowledge across unfamiliar situations: framing problems, diagnosing failures, interpreting documentation, designing validation, and explaining uncertainty. It differs from the core by emphasising demonstrated application and transfer, although the two are mutually dependent. An unfamiliar-tool task can provide evidence of portability, but it is not the only valid assessment and must not become a test of unsupported speed. Students need equivalent documentation, access, preparation, and accessibility support. Rubrics should reward reasoning, validation, and reflection, supplemented by work samples and oral explanation. Assessment can then remain comparable across tool versions.

5.3. Layer three: industry interface modules

Bounded modules address current tools, standards, and practices through achievable learning outcomes. Examples include evaluating an AI service, adapting a deployment workflow, and comparing tools for the same task. They must assess more than exposure or attendance. A first review after twelve to eighteen months is an illustrative governance choice, not an estimated lifespan or compulsory replacement interval. Review may retain, revise, or retire a module. A reserved credit envelope allows replacement without altering the award structure; credits and teaching time should still reflect the learning required.

5.4. Governance through review dates and version control

Modules should record their outcomes, dependencies, version, review date, evidence sources, and decision-maker. Review dates trigger appraisal, not automatic deletion. Retirement criteria include loss of support, superseded standards, unsafe practice, and tasks no longer representing the intended role. A joint board should include both institutions and external expertise, with delegated authority within regulatory limits. Version transitions require equivalent outcomes, notice, accessible resources, and protection of earned credits. Transfer assessment should confirm attained learning and readiness for further study; it cannot be called predictive without validation. Monitoring without authority cannot change a plan, while authority without transition safeguards can disadvantage enrolled students.

5.5. Relationship to alignment and modularisation

Constructive alignment connects outcomes, teaching, and assessment; modularisation provides replaceable units. Neither is necessarily static. The additional contribution here connects heterogeneous renewal needs to decisions about what is reviewed, what evidence triggers change, who approves it, and how current students continue. A data-validation project, for example, can retain statistical concepts and an evidence-evaluation rubric while changing its platform. An equivalence check establishes whether the new implementation still serves agreed outcomes. This is a proposed design example, not a report of an implemented intervention.

6. Implications for AI-Related Vocational and Undergraduate Education

The framework applies across regions, but implementation depends on institutional capacity. Programs need access to current occupational knowledge, teachers able to interpret it, and authority to revise arrangements. Proximity to firms helps but is neither necessary nor sufficient. Professional associations, institutional networks, remote practitioner participation, and shared resources can also supply information. These are proposed implementation routes, not evidence that the architecture produces identical outcomes in all settings.

First, renewal should be organised around access to expertise rather than a particular industrial cluster. Well-resourced institutions can maintain multiple partnerships and rotating projects. Others can pool development and external review through regional or sectoral consortia. A single vendor should not determine the core curriculum or become the sole source of assessment standards. Multiple feedback sources help distinguish durable changes in practice from temporary recruitment preferences and product promotion.

Second, governance should follow actual decision rights. Coordination should be organised at the level able to exercise the necessary authority

across partner institutions. The institutions need an agreement specifying joint decisions, requirements for external approval, and treatment of enrolled students. Third, early warning should precede graduation. Loss of tool support, repeated transfer difficulties, and divergence between assessed tasks and reviewed occupational requirements can trigger appraisal. These signals justify investigation, not automatic removal. Student representation and advice about progression, transfers, and alternative routes matter because adjustment costs are unevenly distributed.

Three risks require attention. Excessive updating fragments learning and transmits industrial volatility into classrooms; stable outcomes and the elastic core provide continuity. Teacher development and assessment equivalence require funded time, not simply a directive to innovate. Unequal access to computing resources and expertise can also widen differences between programs. Shared resources and transparent minimum requirements are therefore part of implementation. The aim is timely, educationally justified renewal rather than the maximum possible rate of change.

7. Propositions for A Research Agenda

Four propositions make the framework open to challenge. They do not imply that this paper has collected data or demonstrated educational effects. Testing would require explicit outcomes and attention to differences in student intake, resources, teaching quality, and occupational context.

P1. Relative durability differs across curricular elements. Given a defined task domain, baseline, unit, and relevance criterion, tool-specific procedures should need substantial revision sooner than explanatory principles. Historical syllabi, standards, documented support, and practitioner judgements could test this expectation. No consistent difference, or poor agreement on relevance, would challenge the classification. Occupational popularity alone should not define educational worth.

P2. Timely renewal is associated with transfer capability where requirements change. At comparable articulation and student preparation, programs with shorter delays between justified review triggers and implemented revisions should support stronger performance on unfamiliar related tasks. The claim concerns responsiveness to material change, not update frequency alone. Longitudinal comparisons must address resources, selection, and reverse causation before attributing differences to renewal.

P3. Assessment rigidity strengthens curriculum persistence. When progression assessment depends on specific implementations and is difficult to revise, outdated requirements should persist longer after documented external change. This relationship should weaken where stable capability criteria permit equivalent replacement tasks. Evidence that assessment revision is unrelated to teaching renewal would weaken the proposed mechanism.

P4. Delegated revision authority reduces barriers to renewal. Within a stable credit envelope and with teacher support, programs able to replace equivalent modules without reopening the whole plan should experience shorter revision delays. The explanatory variables are decision rights, workload, and dependency constraints; low credit weight alone should not generate participation. Review records, approval times, and development workload could provide evidence.

8. Limitations and Conclusion

This perspective has three limitations. It neither estimates half-lives nor tests the mechanisms, and its selective literature base cannot establish their prevalence. Distinguishing durable concepts from changing implementations requires domain-specific judgement; some modules combine both, and not every tool update changes educational requirements. Finally, applicability beyond Chinese '3+4' pathways and AI-related learning depends on qualification rules, autonomy, resources, and occupational change. These limits bound the claims without removing the design problem: coherent progression alone does not ensure continuing relevance.

Structural temporal mismatch must be addressed alongside articulation. Front-loaded commitments slow coordinated revision, rapidly changing tool-dependent tasks can outpace it, and assessment and partnership arrangements sustain lock-in where feedback and authority are weak. These mechanisms explain why improving the institutional join is insufficient without a functioning renewal process. They also identify possible interventions. The educational criterion is not whether each topic remains fashionable at graduation, but whether students retain explanatory knowledge, current capabilities, and the capacity to learn beyond the tools initially taught.

The practical priority is explicit responsibility for renewal. Curricular elements need justified review schedules, evidence-based revision criteria, named decision authority, and safeguards for enrolled students. The elastic core, portable capabilities, and replaceable industry interface modules distribute that responsibility without sacrificing continuity. A seven-year pathway can then be designed as a sustained process of learning and revision. Its promise depends both on how its stages connect and on how effectively it renews what those stages contain.

Conflict of Interest

The author(s) declare that there are no conflicts

of interest to this work.

Acknowledgement

This work was supported by the 2026 University-level Quality Project entitled "AI-empowered Curriculum" at Shenzhen Polytechnic University.

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How to Cite: Kong , H & Kong , C. (2026). When the Half-Life of Curriculum Is Shorter Than the Program: Rethinking China's '3+4' Pathways in the AI Era. *Contemporary Education and Teaching Research*, 7(11), 415-421.https://doi.org/10.61360/BoniCETR262021091108