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Culturally Based Unplugged Coding and Creatif Thinking: A Systematic Literature Review

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ABSTRACT

Indonesia's traditional games, folktales, and arts remain a largely untapped resource for early computational thinking (CT) education, a field still shaped by Western frames. Unplugged coding offers a developmentally appropriate, screen-free route into CT, yet how it works when grounded in local culture, and how it relates to creative thinking, has not been synthesised. This study addresses that gap through a systematic literature review guided by PRISMA 2020. Searches of Scopus and Google Scholar covered 2015 to 2026. Of 476 records identified, 18 studies met the inclusion criteria and were synthesised thematically. Three patterns emerged. Cultural integration took four forms: narrative-based coding, traditional-game and familiar-context coding, local-wisdom curriculum and materials, and teacher-designed culturally responsive activities. The approach supported creative thinking through three mechanisms: creative expression, divergent thinking, and creative confidence, although direct evidence rested largely on a single study. The corpus also sat on two axes, from strictly unplugged to plugged activity and from explicit local wisdom to broader cultural framing, with the strictly unplugged and local-wisdom combination concentrated in Indonesian work. The review supports neither the claim that the approach transforms early CT education nor the view that culture is mere decoration. It recasts culture less as a motivational layer than as a pedagogical mechanism that can bridge computational and creative thinking when it forms the activity's generative core. A four-dimensional framework of cultural grounding, computational scaffolding, creative activation, and professional enablement is proposed.

Informasi Artikel

Kata Kunci:

unplugged coding; berpikir komputasional; kearifan lokal; berpikir kreatif; pendidikan anak usia dini

ABSTRAK

Permainan tradisional, cerita rakyat, dan seni Indonesia sebagian besar belum tergarap bagi pendidikan berpikir komputasional (computational thinking/CT) usia dini, bidang yang masih dibentuk kerangka Barat. Unplugged coding menawarkan jalur menuju CT yang sesuai perkembangan dan bebas layar, tetapi cara kerjanya ketika berlabuh pada budaya lokal, serta kaitannya dengan berpikir kreatif, belum disintesis. Penelitian ini merespons celah tersebut melalui tinjauan pustaka sistematis yang dipandu PRISMA 2020. Pencarian di Scopus dan Google Scholar mencakup 2015 sampai 2026. Dari 476 rekaman yang teridentifikasi, 18 studi memenuhi kriteria inklusi dan disintesis secara tematik. Tiga pola muncul. Integrasi budaya mengambil empat bentuk: coding berbasis narasi, coding berkonteks permainan tradisional dan hal yang akrab, kurikulum dan bahan ajar kearifan lokal, serta aktivitas responsif budaya rancangan guru. Pendekatan ini menstimulasi berpikir kreatif melalui tiga mekanisme: ekspresi kreatif, berpikir divergen, dan kepercayaan diri kreatif, meskipun bukti langsungnya sebagian besar bertumpu pada satu studi. Korpus juga berada pada dua sumbu, dari aktivitas unplugged murni hingga berlayar dan dari kearifan lokal eksplisit hingga pembingkaian budaya luas, dan kombinasi keduanya terpusat pada karya Indonesia. Tinjauan ini tidak mendukung klaim bahwa pendekatan ini mentransformasi pendidikan CT usia dini, maupun pandangan bahwa budaya sekadar hiasan. Tinjauan memosisikan budaya bukan sebagai lapisan motivasional, melainkan sebagai mekanisme pedagogis yang dapat menjembatani berpikir komputasional dan berpikir kreatif ketika budaya menjadi inti generatif aktivitas. Kerangka empat dimensi yang terdiri atas cultural grounding, computational scaffolding, creative activation, dan professional enablement diusulkan.

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1. Introduction

The rapid development of digital technology has increased the global need for computational thinking (CT) skills in future generations. CT encompasses systematic problem-solving, pattern recognition, algorithmic reasoning, and abstraction [1]. These competencies are now regarded as foundational twenty-first-century literacy [1], [2], [3] . In early childhood education (ECE), the early introduction of CT has received growing attention, as it is viewed as a foundation for preparing children to become active, creative, and reflective participants in a world shaped by digital systems and artificial intelligence [4], [5], [6].

Unplugged coding is one approach that is developmentally appropriate for young children. It introduces CT concepts without digital devices by drawing on physical activities, play, and the manipulation of concrete objects. Through these activities, the approach introduces foundational concepts such as sequencing, algorithms, conditionals, and loops [7], [8], [9]. The approach suits children at the preoperational and early concrete operational stages, reflecting the constructionist view that children construct knowledge through play and direct engagement with their environment [5], [10], [11]. Recent experimental evidence from Indonesia reinforces this approach, showing that unplugged coding media significantly improved computational thinking and problem-solving in children aged 5–6 years [12].

Other research has demonstrated that screen-free and physical computing approaches hold potential for broadening access and participation in CT introduction, particularly in settings with limited technological infrastructure [13], [14]. Yet this is not the only consideration in developing CT learning. A body of studies indicates that CT learning experiences need to be designed to carry cultural relevance and to connect with children's everyday lives. In the context of early childhood, local cultural practices, local stories, traditional games, and daily routines can serve as familiar and meaningful learning contexts for introducing computational concepts more concretely.

Indonesia holds an abundance of cultural wealth, including traditional games, folktales, batik motifs, and performing arts. Early childhood CT education has largely yet to draw on this wealth. Recent Indonesian evidence shows that CT skills can grow through culturally grounded coding, including through a culture-based coding e-book drawing on North Sumatran culture to strengthen CT [15] and unplugged coding games in resource-limited settings [16]. These open opportunities to develop more contextual and culturally relevant models of culturally based unplugged coding for Indonesian children.

Both fields of research have developed in parallel, yet synthesis capable of linking them within the context of early childhood education remains very limited. Most studies tend to examine each field separately: some focus on CT without connecting it to cultural dimensions, while others explore culture-based learning without particular attention to the development of creative thinking [17], [18]. Several recent literature reviews have addressed coding and CT in early childhood generally [19], [20], [21], [22].[23] but none has specifically integrated a discussion of how culturally based unplugged coding supports the development of children's creative thinking ability. These reviews generally position instructional approaches as means of enhancing engagement or learning motivation. Ningrum et al. [24] however, emphasise that an instructional approach must be understood not merely as a motivational tool but as a form of pedagogical mediation that shapes children's learning processes and knowledge construction.

Furthermore, no review has comprehensively explained how teachers integrate local cultural elements in unplugged coding activities across diverse learning contexts, which creative skills can be developed through culturally based unplugged coding, or what challenges arise in its implementation. This gap is the primary focus of the present study.

2. Metode

2.1 Research Design

This study uses a systematic literature review (SLR) to gather research evidence on culturally based unplugged coding in early childhood education. The PRISMA 2020 method was applied to ensure procedural transparency and consistency in the study selection process. Because studies in this field employ varied designs, scopes, and methodological orientations, and because the field continues to develop, this review uses narrative synthesis based on thematic analysis rather than statistical meta-analysis. This choice allows the context of each study to remain clearly preserved while revealing the interconnections among culture, unplugged coding, and the development of children's creative thinking.

2.2 Search Strategy

The search covered two sources, Scopus and Google Scholar, selected together to provide broad coverage of international and national work on CT, unplugged coding, cultural integration, and early childhood education. The search was conducted for publications from 2015 to 2026 with no language restrictions at the initial stage, but only articles in English and Indonesian passed the screening. The strategy used four keyword clusters (Table 1) combined with Boolean AND and OR operators to maintain both precision and breadth.

Tabel 1 Keyword search strategy

Category	Keywords
Unplugged coding	unplugged coding OR unplugged activities OR screen-free coding OR physical computing
Computational thinking	computational thinking OR CT OR algorithmic thinking OR programming

Category	Keywords
	concepts
Cultural integration	culturally responsive OR local wisdom OR indigenous knowledge OR traditional games OR folk narrative OR culture-based learning
Early childhood education	early childhood education OR preschool OR kindergarten OR young children

2.3 Eligibility Criteria

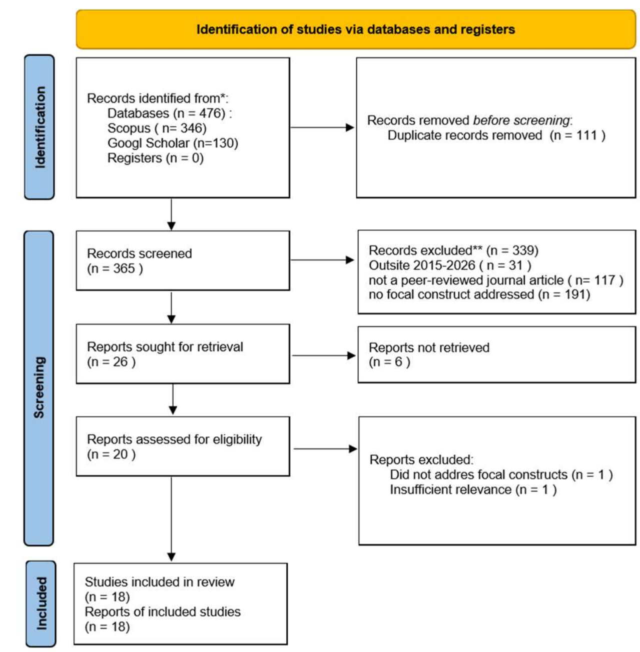
The review established eligibility criteria before screening to ensure consistent and topically appropriate study selection (Table 2).

Tabel 2. **Eligibility criteria**

Criteria	Inclusion	Exclusion
Publication range	2015–2026	Published before 2015
Language	English or Indonesian	Other languages
Document type	Peer-reviewed journal articles	Books, theses, editorials, proceedings, opinion pieces
Thematic relevance	Addresses at least two of three focal constructs: unplugged coding, cultural integration, and creative thinking in ECE	Addresses fewer than two focal constructs
Population	Children aged 0–8 years, teachers, or parents in ECE settings	Secondary or higher education population without ECE relevance
Accessibility	Full text available	Abstract only or full text inaccessible
Research quality	Clear design, transparent methodology, explicit reporting	Unclear design or insufficient methodological detail

2.4 Selection Procedure

The study selection process followed the PRISMA 2020 sequence of identification, screening, eligibility assessment, and inclusion. A total of 476 records were identified from two databases: Scopus (n = 346) and Google Scholar (n = 130). No additional records were identified through registers. Before screening, 111 duplicate records were removed, leaving 365 records for title and abstract screening. During screening, 365 records were reviewed for topical relevance, and 339 were excluded with reasons. This left 26 reports for full-text retrieval and eligibility assessment. However, 6 articles were inaccessible in full text, leaving 20 articles that were successfully assessed. Of these, 6 reports were excluded after full-text review for three main reasons: insufficient focus on unplugged coding (n = 1) and irrelevance to early childhood education (n = 1). Accordingly, the final synthesis includes 18 studies. The selection flow is illustrated in Figure 1. The PRISMA flow reports the following counts: records identified (n = 476), records removed before screening (n = 111), records screened (n = 365), records excluded (n = 339), reports sought for retrieval (n = 26), reports not obtained (n = 6), reports assessed for eligibility (n = 20), reports excluded (n = 2), and studies included in the review (n = 18).



Gambar 1. PRISMA 2020 diagram of the selection process

2.5 Quality Appraisal

The review appraised methodological quality to increase the credibility of its interpretations. Because the included studies employ different designs, assessment instruments were matched to design type: the Critical Appraisal Skills Programme (CASP) checklist for qualitative designs and case studies, the Mixed Methods Appraisal Tool (MMAT) for mixed-methods studies, and for conceptual and development studies, a focus on procedural clarity, coverage, and reasoning. Each study was assessed across four aspects: methodological appropriateness, design quality, findings clarity, and relevance to the research questions. The review retained only studies reaching at least a moderate quality threshold, and retained moderate-quality studies when they still contributed useful ideas or context.

2.6 Data Analysis

Data analysis was conducted through thematic analysis combined with narrative synthesis. Data extraction used a standardised form recording the study focus, findings for each research question, and practical implications. The review then noted how strongly each study addressed each research question and placed studies on two categorisation scales. The first scale was activity type: strictly unplugged, screen-free physical computing, or screened robotics. The second scale was the cultural meaning in the study: explicit local wisdom, culturally responsive learning, maker or family culture, or broader social and cultural support. The analysis then followed three steps: identifying recurring ideas across studies, grouping similar ideas into categories related to the research questions, and refining them into three main themes structuring the findings and discussion. Because the evidence base is conceptually and methodologically diverse, this synthesis does not pursue statistical aggregation but aims to produce an analytically coherent account of how culturally based unplugged coding is positioned and operationalised in early childhood learning, and where important gaps remain in the literature.

3. Results and Discussion

3.1 Study Quality Profile

The 18 studies provide a sufficiently strong but varied evidence base in terms of design, scope, and depth. Most reach a high or medium-high quality level, and some are at a medium level because they still address the review questions despite weaker designs or narrower scope. The strongest studies clearly connect instructional design, cultural content, and learning outcomes. These include quasi-experimental and longitudinal studies [14], [25], [26], as well as qualitative and design-based studies that describe practice in detail [8], [17], [27], [28]. Development studies [29], [30] and training- or community-based action research [31], [32] demonstrate strong validity and practicality, but their causal evidence is weaker. The review retained the conceptual curriculum model [33] because its context is useful even though it has not been empirically tested. Table 3 presents the per-study appraisal, using CASP for qualitative and case-study designs and MMAT for quantitative and mixed-methods designs.

Table 3. Quality appraisal of the included studies using the CASP checklist and the MMAT

No	Study ID	Methodology appropriateness	Research design quality	Findings clarity	Quality rating
1	Bergman dkk., (2026)	High. Prototype-based design suited to an emerging screen-free physical-computing curriculum.	Moderate. Pilot stage with a small sample; largely descriptive of three prototypes.	Clear. Articulates the seven powerful ideas and maker literacies.	Medium-High
2	Bourha dkk.,(2026)	High. Qualitative sociocultural observation appropriate for free-play CT.	Strong. Systematic observation across four ECE settings.	Very Clear. Distinguishes open- from closed-ended toys.	High
3	Daniele dkk.,(2025)	High. Qualitative transmedia study fits multimodal literacy.	Strong. Eight-week design across home–museum contexts.	Excellent. Maps CT to gesture, drawing, speech, and materials.	High
4	Dia dkk.,(2024)	High. ADDIE development suited to producing teaching materials.	Strong. High validity (mean 0.91) with positive pupil response.	Clear. Reports validity, practicality, and effectiveness.	Medium-High
5	Harahap & Eliza (2022)	High. ADDIE R&D appropriate for an e-module.	Strong. Validity 87%, practicality 89.7%, pretest–posttest gain 88%.	Clear. Quantifies validity and effectiveness.	Medium-High
6	Harper dkk.,(2023)	High. Participatory design-based research centers stakeholder voice.	Strong. Community-based and qualitatively rich.	Excellent. Surfaces teacher–parent tensions and culture–CT frictions.	High
7	Hu & Wang (2024)	Excellent. Quasi-experiment with a control group isolates effects.	Very Strong. Significant gains on CT and three creativity dimensions (t = 5.83–7.55).	Excellent. Establishes creativity as a predictor of CT.	High
8	Hubelbank dkk.,(2024)	High. Three-year research–practice partnership suited to PD.	Strong. Pre/post survey across PreK–5 teachers.	Very Clear. “Not ready” fell 55.6%→0%.	High
9	Kamiliyah dkk.,(2025)	High. Community-based action research fits a rural introduction.	Moderate. Observational, single-site, limited measures.	Clear. Reports a 40% rise in active participation.	Medium-High
10	Lee & Cho (2021)	High. Delphi-based instrument development is appropriate.	Strong. Two-round Delphi with content-validity thresholds.	Clear. Distinguishes CT from creativity for assessment.	High
11	Lyublinskaya dkk.,(2024)	High. Year-long design-based co-design suited to teacher PD.	Strong. Demand–relevance–agency rubric across 50	Very Clear. Documents growth in cultural competence.	High

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No	Study ID	Methodology appropriateness	Research design quality	Findings clarity	Quality rating
			activities.		
12	Masarwa dkk.,(2024)	High. Developmental pretest–intervention–posttest design.	Strong. Measures three CT skills; small sample (n = 16).	Clear. Intermediate→advanced gains with learning phases.	Medium-High
13	Mutoharoh (2021)	Moderate. Conceptual curriculum-development proposal.	Average. Comprehensive but not empirically tested.	Clear. Presents an integrated curriculum model.	Medium
14	Prantsoudi dkk.,(2025)	High. Multi-site case study within an Erasmus+ project.	Strong. 7 teachers, 17 lesson plans, 155 pupils.	Excellent. CT objectives met in 94.12% of cases.	High
15	Quinn dkk.,(2025)	High. Practitioner–researcher inquiry in real classrooms.	Strong. Grounded in the seven powerful ideas framework.	Excellent. Shows culture as structural, not decorative.	High
16	Sari dkk.,(2026)	High. Training-based action research suited to teacher PD.	Strong. Pre/post with a significant paired-t result.	Clear. Competence rose 81% (45.5→82.3).	Medium-High
17	Yang dkk.,(2022)	Excellent. Mixed-methods case study with pre/post measures.	Very Strong. Significant CT gains; ecological barrier analysis.	Excellent. Identifies micro/meso/macro barriers.	High
18	Zviel-Girshin dkk.,(2024)	Excellent. Longitudinal design with objective and subjective measures.	Very Strong. n = 114; chi-square gender analysis (χ^2 = 13.76).	Excellent. Reports beliefs vs objective ability and a gender effect.	High

3.2 Characteristic of the Included Studies

Synthesis of the 18 studies produced three themes corresponding to the research questions: forms of culturally based unplugged coding, how the approach stimulates creative thinking, and an integrative view of challenges, opportunities, and the conceptual framework. The corpus is diverse in two respects. First, activities range from strictly unplugged tasks [14], [29], [30], [34], [35] through screen-free physical computing [13], [36], to screened robotics [26], [27], [37] . Second, studies conceptualise culture differently: as explicit local wisdom in Indonesian studies, as culturally responsive teaching in US studies, and as maker, family, or sociocultural framing in other studies. Table 4 summarises the characteristics of all 18 studies.

Table 4. Characteristics of the synthesized studies

No	Author & Year	Aim & Design	Sample & Age	Strategy / Subcategory	Key results
1	Bergman dkk.,(2026)	Extend the Coding as Another Language (CAL) curriculum to screen-free physical computing; prototype-based design	Kindergarten–Grade 1; teachers & curriculum designers	Three prototypes (conductive clay, e-textile pins, soundboard); tangible artifacts encoding community/cultural values; story-based making	Children develop the seven CT "powerful ideas" and operational/cultural/critical maker literacies; bridging digital–physical remains a design challenge (pilot, small sample)
2	Bourha dkk.,(2026)	Observe CT, problem solving, and collaboration in free play with technology-enhanced toys (TETs); qualitative sociocultural study	37 children 3–4 yrs; 4 ECE settings, Greece	Free play with Bee-Bot, Coko Robot, dog robot; open- vs closed-ended toys; screen-free physical computing	Open-ended/programmable toys elicited richer problem solving, CT, sequencing, and collaboration; openness of design and interaction quality mattered more than toy sophistication
3	Daniele dkk.,(2025)	Foster multimodal literacy and CT via transmedia STEM in a children's museum; qualitative study	Children 5–9 yrs & parents, Australia	8-week transmedia program; CT as multimodal literacy across gesture, drawing, speech, material exploration; parent scaffolding	Children showed decomposition, pattern recognition, and algorithmic reasoning across modalities; resource-light and replicable; access and language inequities noted
4	Dia dkk.,(2024)	Develop & validate a traditional-game-based CT supplementary textbook; ADDIE	Grade 4 pupils; teachers, Indonesia	Four Indonesian games (Congklak, Setatak, Galah Panjang, Yeye) mapped to decomposition, pattern, abstraction, algorithm	Very high validity (mean 0.91); positive pupil response due to cultural and game familiarity; CT can be introduced without technology
5	Harahap & Eliza (2022)	Develop & validate a culture-based coding e-module to enhance CT; ADDIE R&D	Children 5–6 yrs; teachers, Indonesia	Worksheet-style e-module embedding CT in Batak Angkola & Minangkabau symbols (houses, dress, foods)	Validity 87%, practicality 89.7%, effectiveness 88% (pretest–posttest); a low-tech alternative for schools without computers
6	Harper dkk.,(2023)	Center teacher and parent voice for culturally relevant CT; participatory design-based research	Preschool teachers, parents, BIPOC children 3–5 yrs, USA	Unplugged CT linked to familiar home/school routines (making a sandwich, buying eggs); co-design	Teacher and parent voice essential; teachers prioritized CT-as-access while parents prioritized cultural values; some CT concepts (linear sequencing, "error"/debugging) may conflict with cultural ways of knowing
7	Hu & Wang (2024)	Test effects of unplugged activities on CT and mathematical creativity; 10-week quasi-experiment	Grade 3 (8–9 yrs), Chongqing, China; experimental vs control	Unplugged via 5E model (math games, logic boards, shopping simulation) vs lecture; familiar everyday contexts	Unplugged group significantly higher on CT and three creativity dimensions: problem-posing ($t = 5.83$), problem-solving ($t = 6.63$), creative self-efficacy ($t = 7.55$), all $p < .01$; creativity predicted CT
8	Hubelbank dkk.,(2024)	Build teacher knowledge/confidence for culturally responsive CT (PreK–5); 3-year research–practice partnership	PreK–5 teachers, administrators, researchers, USA	3-day PD via RPP/DBIR; unplugged (story-sequencing, object sorting) + plugged (Bluebot, Bee-bot, Ozobot); CRP linked to home/community culture	"Not ready" to teach CT fell from 55.6% to 0%; significant gains in confidence and knowledge; persistent gap between CT knowledge and culturally responsive practice
9	Kamiliyah dkk.,(2025)	Introduce & strengthen unplugged coding in rural ECE; community-based action research	Children 3–7 yrs; rural ECE, Kediri, Indonesia	Four local-context sessions: Robot–Programmer, Rainbow Mathematics, Number-Code Song, Movement 1-2-3	Teacher capacity rose; active child participation +40%; low-tech approach effective in resource-limited settings; a teacher learning group formed
10	Lee & Cho (2021)	Develop CT and software-education	Early childhood	SW-education effectiveness test (4 areas/13 sub-areas) + image-based CT test adapted	Tools validated; CT and creativity are distinct domains best assessed

No	Author & Year	Aim & Design	Sample & Age	Strategy / Subcategory	Key results
		evaluation tools for early childhood; instrument development	(Korea); experts (Delphi)	from Bebras; content validity via two-round Delphi	separately, though emphasizing CT may also raise creativity
11	Lyublinskaya dkk.,(2024)	Develop teachers' cultural competencies via co-design of robot-coding mathematics; year-long design-based research	Two elementary teachers + researchers; Latinx & Black students, NYC	Co-designed 50 culturally relevant Finch robot-coding math activities (Lego, Pokémon, Minecraft, NYC contexts); demand–relevance–agency rubric	Strengthened cultural competence, culturally responsive pedagogical knowledge, and agency; teachers came to view robots as mathematical tools, not motivational add-ons; long-term PD/structural support needed
12	Masarwa dkk.,(2024)	Develop & assess an unplugged card-sorting CT unit; pretest–intervention–posttest	16 kindergarteners 5–6 yrs, Israel	Unplugged Linear Sort & Category Sort using familiar objects (cards, Lego, images)	All three CT skills rose from intermediate to advanced; sorting attributes 1→2; three algorithm-learning phases; significant teacher scaffolding required; unplugged CT under-researched
13	Mutoharoh (2021)	Propose a comprehensive local-wisdom ECE curriculum integrated with coding; conceptual curriculum development	ECE educators & curriculum designers; Indonesia (Banten)	Coding (plugged & unplugged) integrated across all KTSP documents; "Kebantenan" theme (foods, batik, old Banten, traditional games); CT mapped to decomposition/pattern/abstraction/algorithm	A comprehensive conceptual integration model across curriculum documents; teacher competence and documentation complexity as challenges; conceptual, not empirically tested
14	Prantsoudi dkk.,(2025)	Integrate CT into language/literature/arts via culturally responsive unplugged activities; case study	7 teachers, 17 lesson plans, 155 pupils 6–10 yrs, Greece (Erasmus+)	Unplugged, culturally responsive CT via myths, folktales, folk songs, recipes, traditional crafts; cross-subject integration	Very high engagement (64.71%); CT objectives met in 94.12% of cases; teachers practiced CT unknowingly; PD and flexible lesson design needed
15	Quinn dkk.,(2025)	Integrate culturally relevant CT into preschool routines; practitioner–researcher design	Two composite teachers (Latinx bilingual; Black); preschoolers 3–5 yrs, USA	Seven CT powerful ideas woven into existing routines (centers, small groups, read-aloud); unplugged "playground," loose parts, identity-affirming books	Cultural relevance must be structural, not decorative; engagement and belonging strengthened; creativity not quantified
16	Sari dkk.,(2026)	Train ECE teachers to make local-wisdom unplugged-coding worksheets via Canva; training-based action research	50 ECE teachers, Banjarmasin, Indonesia	Lecture–demonstration–practice–mentoring; Banjar contexts (river, floating market, jukung/klotok) in Canva worksheets	Teacher competence rose 81% (45.5→82.3; paired t significant); the creativity measured was teachers' design creativity, not children's
17	Yang dkk.,(2022)	Test CT outcomes and implementation barriers of screen-free robot programming; mixed-methods case study	18 kindergarteners 5–6 yrs + teachers, low-income Hong Kong	6-week Story-Inspired Robot Programming (Matatalab); narrative/thematic contexts	CT improved significantly; self-regulation change non-significant but predicted by child–robot interaction; micro/meso/macro barriers incl. Confucian norms
18	Zviel-Girshin dkk.,(2024)	Examine children's beliefs and objective abilities to read/write programs; longitudinal	114 children 5–7 yrs (ROPEC), Israel	LEGO WeDo block-based robotics; story-inspired capstone; Vygotskian "coding as a playground" scaffolding	83.3% confident writing and 84.2% reading code; 63.2% objectively able; girls outperformed boys on objective reading/explaining ($\chi^2 = 13.76$, $p = .001$), narrowing the gender gap. The study was conducted in an on-screen format only, and the authors recommend extending future research to tangible and unplugged approaches.

3.3 Forms of Implementation of Culturally Based Unplugged Coding

Studies reveal four recurring forms through which cultural elements are added to children's coding: narrative or story-based coding, traditional-game and familiar-context coding, local-wisdom curriculum and teaching materials, and teacher-designed culturally responsive activities. These four forms are not rigidly separate, and several studies combine them. They also occupy different points on the unplugged-to-plugged continuum.

Narrative or story-based coding uses cultural stories, themes, and celebrations to introduce computational concepts. Yang et al. [37] situated robot programming within a story-themed curriculum, and Zviel-Girshin et al. [26] framed the robotics project as story-themed problem solving. Both use screens, but they show how narrative can bridge children to algorithmic reasoning. Bergman et al. [13] invited children to encode stories and community values into screen-free physical objects, and Quinn et al. [28] used read-aloud activities and story-sequencing within daily routines. These cases point to narrative as a natural starting point for meaningful coding. In some of them, however, the cultural content remains thematic rather than anchored to a specific local tradition.

Traditional-game and familiar-context coding appears most frequently in Indonesian studies and mathematics classrooms. Dia et al. mapped four Indonesian games (Congklak, Setatak, Galah Panjang, and Yeye) onto decomposition, pattern recognition, abstraction, and algorithm [29]. Their work shows that local games already contain algorithmic structures that teachers can make explicit. Hu and Wang [38] and Masarwa et al. [34] built unplugged activities from familiar everyday contexts and objects rather than from explicit local wisdom. The cultural content is thinner, but both illustrate how flexible unplugged tasks become when they start from what children already know.

Local-wisdom curriculum and teaching materials is the form that most clearly shows culture working as a structural foundation rather than surface decoration, and it is almost entirely Indonesian. Mutoharoh [39] proposed weaving coding into every layer of the ECE curriculum using regional cultural themes, such as the Kebantenan theme comprising local foods, batik, Banten history, and traditional games. Harahap and Eliza [30] embedded CT skills in Batak Angkola and Minangkabau cultural symbols, and their e-module achieved 87% validity, 89.7% practicality, and 88% effectiveness. Sari et al. (2026) raised teacher competence by 81% (from 45.5 to 82.3) through Banjar river-culture worksheets, while Kamiliyah et al. [31]] ran low-technology sessions based on familiar local songs and games in rural areas. Across these studies, treating local wisdom as a foundation rather than decoration made the curriculum more coherent and more feasible to implement.

Teacher-designed culturally responsive activities rely on research–practice partnerships. Hubelbank et al. [18]] and Lyublinskaya et al. [27] found that co-design produced more authentic and durable activities than top-down adoption, and teachers came to view robots as mathematical tools rather than motivational add-ons. Quinn et al. [28] and Harper et al. [17]] placed teacher and parent voices at the centre of design. Prantsoudi et al. [8] wove culturally responsive unplugged CT into language, literature, and arts lessons, demonstrating that unplugged coding needs no separate curriculum slot. In these studies, culture means culturally responsive teaching for Latinx, Black, multicultural, or Greek learners rather than specific local wisdom.

Table 5. Mapping of implementation forms across studies

Implementation form	Key studies	How “culture/context” is operationalized
Narrative / story-based coding	Yang dkk., (2022); Zviel-Girshin dkk., (2024); Quinn dkk., (2025); Bergman dkk., (2026)	Thematic/narrative framing; maker-community values
Traditional-game & familiar-context coding	Dia dkk., (2024); Hu & Wang (2024); Masarwa dkk., (2024)	Indonesian traditional games; familiar everyday contexts (China/general)
Local-wisdom curriculum & teaching materials	Mutoharoh (2021); Harahap & Eliza (2022); Kamiliyah dkk., (2025); Sari dkk., (2026)	Explicit Indonesian local wisdom (Banten, Batak, Minangkabau, Banjar)
Teacher-designed culturally responsive co-design	Harper dkk., (2023); Hubelbank dkk., (2024); Lyublinskaya dkk., (2024); Quinn dkk., (2025); Prantsoudi dkk., (2025)	Culturally responsive pedagogy (Latinx, Black, multicultural; Greek)
Screen-free physical computing & transmedia	Bergman dkk., (2026); Bourha dkk., (2026); Daniele dkk., (2025)	Maker culture; sociocultural mediation; family/community

Implementation form	Key studies	How "culture/context" is operationalized
(unplugged-adjacent)		culture

Table 5 maps these forms across studies. The mapping shows that adding culture to unplugged coding is more than a motivational supplement. At its strongest, culture becomes the foundation that generates the activity, not a surface layer. This shift changes the logic from teaching CT through culture to understanding CT as cultural practice. Because it requires no devices, unplugged coding is readily adaptable to local culture. The mapping also clarifies one pattern: the strictly unplugged version built on explicit local wisdom is concentrated almost entirely in Indonesian studies, whereas much international work is screen-based or culturally responsive in a broader sense.

3.4 Stimulation of Creative Thinking

Culturally based unplugged coding stimulates creative thinking through three interconnected mechanisms: creative expression through narrative and making activities, divergent thinking through open-ended problem solving, and creative confidence through familiar and playful contexts. One caveat frames this theme. Several studies did not directly measure creative thinking; they relied on observation or treated creativity as a general goal, so the strength of evidence is uneven.

The first mechanism is creative expression through narrative and making activities. When children transform stories, celebrations, or values into computational sequences or physical objects, coding becomes an act of creative authorship. Bergman et al. [13] treated coding as an expressive language, with children using it to build their own narratives and encode cultural values into artefacts. Daniele et al. [40] provided strong evidence of this expression: children composed narratives, experimented repeatedly, and remixed content across gesture, drawing, speech, and materials. Prantsoudi et al.[8] reported children writing pseudocode and composing music with their own notation. Quinn et al. [28] described design processes that opened space for imagination, such as designing a robot to solve a community problem.

The second mechanism is divergent thinking through open-ended problem solving in familiar contexts. Hu and Wang [14] provide the most direct evidence. Their unplugged activities significantly raised CT and three dimensions of mathematical creativity: problem-posing ($t = 5.83$), problem-solving ($t = 6.63$), and creative self-efficacy ($t = 7.55$), all $p < .01$. Mathematical creativity also predicted CT. Dia et al. and Masarwa et al. noted that game-based and sorting tasks invited varied strategies and diverse solutions, although neither formally measured creativity [29], [34]. These tasks simultaneously activated cultural or familiar knowledge and computational reasoning, creating fertile ground for divergent thinking. Lee and Cho [3] focused on assessment and confirmed that CT and creativity are interrelated but distinct, suggesting that researchers should measure them separately with validated instruments.

The third mechanism is creative confidence through familiar and playful contexts. Zviel-Girshin et al. [26] framed coding as a low-risk playground with Vygotskian scaffolding and open-ended challenges. In their study, girls outperformed boys on objective tasks despite reporting lower confidence, suggesting that a playful frame can lower the threshold for creative risk-taking and narrow the gender gap. Bourha et al. [36] observed children aged three to four years in free play with open-ended toys. Children spontaneously solved problems, experimented repeatedly, and collaborated; their creative expression emerged through action, gesture, and material exploration rather than words alone.

Overall, the connection between culturally based unplugged coding and creative thinking appears structural rather than coincidental, but the evidence rests on only a few studies, primarily Hu and Wang [14]. When coding is anchored in cultural or familiar contexts, it can simultaneously activate prior knowledge, emotional engagement, and imagination which are the conditions in which creative thinking flourishes. Even so, most studies still lack direct, validated measures of children's creativity.

3.5 Integrative Synthesis: Challenges, Opportunities, and the Conceptual Framework

Three challenges recur across studies. The first is teacher readiness and competence. Hubelbank et al. [18]] found a persistent gap between teachers' CT knowledge and their confidence in integrating it with culturally responsive teaching, even though the proportion feeling 'not ready' fell from 55.6% to 0% after professional development. Sari et al. [32] and Harahap and Eliza [30] found that many Indonesian ECE teachers were unfamiliar with unplugged coding. Mariyana et al. (2025) reported that teachers were unsure of the meaning of coding and preferred play-based unplugged activities but faced limitations in facilities, training, and curriculum guidance. Yang et al. [25] identified weak Technological Pedagogical Content Knowledge as an additional barrier.

The second challenge is resource availability and equity of access. Yang et al. [28] described barriers at the micro, meso, and macro levels. Conversely, Kamiliyah et al. [31], Hu dan Wang [14], and Daniele et al. [40] showed that low-technology approaches can alleviate the digital divide. Masarwa et al. [34] added that researchers still study unplugged CT far less frequently than digital approaches.

The third challenge is the authenticity of cultural integration. Quinn et al. [28] cautioned against treating culture as decoration. Harper et al. [17] revealed two deeper tensions: first, between teachers, who aim for CT as access, and parents, who aim for the reinforcement of cultural values; second, between certain CT concepts, such as linear sequencing or debugging framed as error, and certain cultural ways of knowing.

These challenges coexist with clear opportunities. The richness of Indonesian traditional games, folktales, batik motifs, and regional practices constitutes an abundant resource that has been largely untapped [29], [30], [39]. Low-technology unplugged approaches work well in resource-limited settings, indicating that culturally based CT requires no expensive infrastructure and can be scaled broadly [14], [30], [31]. Growing evidence on co-design shows that activities endure when teachers serve as co-creators [3], [18], [27]. Lee and Cho [3] add that developmentally appropriate and validated assessment is both possible and necessary, and that CT and creativity should be assessed separately.

This synthesis points to a four-dimensional, mutually reinforcing framework (Figure 2). Cultural grounding means identifying and selecting authentic cultural elements as a structural foundation rather than surface decoration. Computational scaffolding means making CT concepts explicit within cultural contexts through developmentally appropriate sequencing, guided play, and graduated problem solving. Creative activation means intentionally designing clear space for narrative imagination, divergent thinking, and expressive choice alongside computational reasoning. Professional enablement means building teacher capacity through collaborative, practice-based training that simultaneously develops CT knowledge and cultural responsiveness. Effective practice, therefore, is not a matter of adding culture to an existing CT curriculum but of redesigning CT learning from the inside, with culture as its generative core.

3.6 Discussion

The evidence points to conclusions that are narrower and more cautious than the general enthusiasm for coding in early childhood. Two habits of thought warrant scrutiny. The first treats culture as a decorative layer, merely a folkloric skin over what are in effect generic CT activities. The second assumes that an approach succeeds simply because it is unplugged or culture-based. The stronger studies support neither view. Instead, they indicate that culturally based unplugged coding becomes educationally meaningful when culture functions as the activity's generative foundation and when the design is developmentally appropriate [14], [17], [28]. The value of this approach therefore lies not in the absence of devices or the presence of cultural motifs but in the shift it makes possible: introducing CT as cultural practice rather than as a skill taught out of context.

Reading the corpus as a whole clarifies why effectiveness is conditional rather than automatic. Studies lie on a spectrum with two axes. On the modality axis, they range from strictly unplugged tasks [14], [34], through screen-free physical computing [13], [36], to screened robotics [25], [26], [27]. On the cultural axis, they range from explicit local wisdom [29], [30], [31], [32], [33], through culturally responsive pedagogy [8], [17], [18], [27], [28], to maker, family, or sociocultural framing [13], [36], [40]. The combination highlighted by this review, namely strictly unplugged activities anchored in explicit local wisdom, is concentrated almost entirely in Indonesian studies. Most of the international corpus offers unplugged modality without local wisdom content, or culturally responsive content delivered via screen. Recognising this pattern prevents overgeneralisation and locates the specific novelty of Indonesian work.

Regarding creative thinking, its connection to culturally based unplugged coding appears structural rather than coincidental, yet the evidence is thinner than the rhetoric. Only Hu and Wang [14] provide controlled, direct evidence that unplugged activities raise CT alongside distinct creativity dimensions, with creativity predicting CT. Lee and Cho [3] remind us that CT and creativity are related but separable and should be measured with different validated instruments. The remaining support is largely qualitative or observational: expressive authorship in making and narrative activities [8], [13], [40] and creative confidence in low-risk play settings [26], [36]. Several studies frequently cited for creativity actually measured teachers' design creativity [32] or merely named creativity as a general goal [30], [33]. The more useful question is therefore not whether coding raises creativity in general but under what design conditions culturally anchored unplugged tasks activate divergent thinking and creative confidence in children.

The corpus also sharpens the discussion of teacher empowerment and authenticity, which turn out to be decisive implementation conditions rather than minor technical concerns. Co-design and research–practice partnerships repeatedly produced more authentic and durable activities than top-down adoption and also shifted teachers from treating robots or cultural motifs as motivational add-ons to using them as genuine learning tools [18], [27]. Even so, a gap between teachers' CT knowledge and their confidence in integrating it with culturally responsive practice persists [18]. Many Indonesian ECE teachers remain entirely unfamiliar with unplugged coding and are unsure of its meaning, even though they favour play-based unplugged approaches [30], [32], [41] Harper et al. [17] expose the deepest form of the authenticity problem. Teachers and parents may want different things, CT as access versus the reinforcement of cultural values, and some CT concepts, such as strictly linear sequencing or debugging framed as error, may conflict with certain cultural ways of knowing. Authentic integration is therefore not only a matter of choosing the right motifs but also of deciding whose knowledge and whose ways of knowing the curriculum honours.

Finally, context shapes what counts as feasible pedagogy, and transfer cannot be assumed. International studies cluster in Western and East Asian settings, limiting their transferability to Indonesia and the broader Global South. At the same time, low-technology unplugged approaches work well in resource-limited settings [14], [16], [31], [40], which is precisely what makes them attractive where infrastructure is uneven and where distance or cost restricts access to devices. Beyond the reviewed corpus, related Indonesian work, such as the culture-based coding e-book from North Sumatera [15] and the Robokids STEAM coding game digital-literacy programme in early childhood [42], further demonstrates this flexibility. The Indonesian case is therefore not a national exception but one instance of a broader Global South problem: how to make computational thinking education developmentally and culturally feasible under unequal material and institutional conditions. From this vantage point, the enduring value of culturally based unplugged coding lies in its flexibility. It can organize CT learning through familiar narratives, traditional games, and joint participation, and teachers can tune it to local realities.

What this discussion adds, then, is a more cautious picture of where the literature now stands. The evidence does not support the sweeping claim that culturally based unplugged coding transforms early childhood CT education. Nor does it support the opposing view that culture is mere ornament. The more defensible position is that the approach works best under four conditions: culture is treated as the activity's generative core, CT concepts are made explicit through developmentally appropriate scaffolding, creative activation is intentionally designed rather than assumed, and teachers are empowered as co-creators. These four conditions, namely cultural grounding, computational scaffolding, creative activation, and professional enablement, are mutually reinforcing. The framework proposed here (Figure 2) offers a structure for aligning them in curriculum design, teacher preparation, and policy.

3.7 Limitations of the Review

Several limitations qualify these conclusions, and the corpus itself makes some of them visible. The evidence is heterogeneous. Many studies are not strictly unplugged, as Zviel-Girshin et al. [26], Yang et al. [25] and Lyublinskaya et al. [27] used robots or screens. Some do not involve explicit local wisdom but rather culturally responsive teaching or maker, family, or sociocultural framing [17], [18], [36], [40]. Few studies directly measured creative thinking, and most relied on observation or treated it as a general goal. Validated CT assessment tools for early childhood are beginning to emerge [43], and future work can pair them with creativity measures. Several Indonesian studies used a development design such as ADDIE, which prioritises validity and practicality over experimental control and thus limits

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causal claims. Cross-sectional and short-term designs dominate, sample sizes are often small, and publication bias cannot be ruled out. Because the corpus and search were revised during the review, authors should finalise the PRISMA figures against the screening log before submission. This evidence base is therefore best understood as an emerging body of knowledge rather than an established one.

5. Conclusion

This review shows that the contribution of culturally based unplugged coding to early childhood CT education is more specific than broader educational-technology discourse often implies. The reviewed literature does not support the view that culture-based approaches are inherently effective or that cultural content alone can improve computational learning outcomes. What emerges consistently is a narrower but valuable conclusion. Culturally based unplugged coding becomes educationally relevant when it places cultural knowledge, creative expression, and community meaning within the educational environment as the foundation for developing structured computational activities, rather than serving merely as a learning motivator. The value of this approach lies not in its technical novelty but in its capacity to serve as a medium grounded in local wisdom, developmentally appropriate play, and computational knowledge construction. This conclusion is relevant not only to Indonesia but also to other culturally rich and technologically limited contexts where meaningful CT introduction remains a challenge.

Because the included studies vary in design, scope, and analytical depth, conclusions must be read within the review's limits. Few studies directly measured creativity, sample sizes are often small, and longitudinal and child-centred studies remain rare. This review also did not systematically compare culturally based unplugged coding with other approaches, and most studies originate from Indonesia, so application to other cultural contexts should be approached with care. This review therefore does not claim that the approach represents a universal solution for early childhood CT education.

Nevertheless, this review encourages researchers, particularly those in Indonesia, to boldly develop culturally contextual and developmentally appropriate unplugged coding media grounded in local culture. Local cultural wealth such as traditional games, folktales, and performing arts is not merely decorative; it constitutes a powerful pedagogical resource for introducing computational concepts concretely and meaningfully. Such development need not await adequate technological infrastructure, as the unplugged approach itself opens opportunities for contexts that have traditionally been considered limited.

Future research should employ longitudinal, multi-site, and child-centred designs. Creative thinking needs to be assessed with validated instruments alongside CT measures, and studies need to examine how children themselves make sense of cultural elements in computational activities. The practical implications of this review are not to expand cultural content for motivational purposes alone but to strengthen curriculum design, teacher preparation, and context-sensitive implementation. The four-dimensional framework offers one way of translating this principle into practice, ensuring that CT learning remains meaningful for young children.

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