Unpacking Computational Empowerment in Participatory Design with Children: Opportunities, Tensions, and Emerging Questions

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Abstract

This paper advances a collective research manifesto for Computational Empowerment (CE) in Child–Computer Interaction (CCI), grounded in diverse practices across global contexts. Drawing on five cases from Asia, Europe, and North America, we examine how CE commitments materialize in real world settings, revealing both their transformative potential and the tensions they introduce. Our cases illustrate that CE is inherently context dependent, socially situated, and shaped by surrounding structures. We identify key directions for extending CE: embedding critical and ethical perspectives, foregrounding situatedness and relationality, challenging convenient choices, and questioning design assumptions. This involves strengthening children's agency in shaping computational systems and widening CE's reach through more inclusive, sustainable practices. We offer this work as intentionally incomplete—an invitation to ongoing dialogue and collective action toward empowering children in computing.

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CCS Concepts

• **Human-centered computing → Empirical studies in HCI**; **Interaction design**.

Keywords

Computational empowerment, Participatory design, Children

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1 Introduction

This paper advances a collective research manifesto for Computational Empowerment (CE) in Child-Computer Interaction (CCI) and invites the Interaction Design and Children (IDC) community to join, challenge, and extend this work in progress. CE frames participatory design with children as a means to develop children's capacity to critically and creatively explore, question, and shape digital technologies and their societal impact [2, 6, 7, 9]. It emphasizes children's active role in both creating technology and interrogating its underlying structures and consequences, while fostering a generative, hope-oriented perspective [3, 4, 16]. Recently, CE has gained traction as a unifying concept within the research community, catalyzing collaborations and discussions across contexts and disciplines [18].

A key moment in this development was a workshop at the IDC 2025 conference, where an international group of researchers came together to articulate a shared commitment to CE of children [5]. This resulted in a collaboratively defined manifesto that outlines six central commitments, presented in [8]. They emphasize children's active participation in shaping digital technologies and their futures; underscore the importance of critical, ethical, and caring engagement with technology; and advocate for supportive infrastructures and practices that enable more just, inclusive, and hopeful digital futures. These commitments include:

- Positioning children as co-creators and change agents
- Nurturing curiosity and critical exploration of digital technologies
- Fostering care, empathy, and planetary responsibility
- Supporting children in envisioning and nurturing inclusive futures
- Cultivating hope, aiming for just transformations
- Promoting frameworks and infrastructures that support computational empowerment

In this work-in-progress paper, we take the CE manifesto as a point of departure to examine how its commitments are enacted across diverse design practices with children, across global contexts. Drawing on five cases from Asia, Europe, and North America, we unpack both the opportunities and frictions that arise when working with CE in real-world settings. We believe this cross-country reflective piece by practitioners is a valuable contribution since literature on CE reporting experiences across various countries and contexts is scarce. Rather than presenting definitive answers, we surface patterns, tensions, and open questions that cut across contexts.

2 Methodology

We followed a practice-oriented, iterative approach to investigate and reflect on our own CE practices with young people. Building on the IDC 2025 workshop [5], we selected cases from five countries in formal and non-formal education settings, addressing current societal challenges, and situated in diverse contexts, conditions, and durations (see Table 1). Together, these cases incorporate cycles of planning, action, and reflection and offer opportunities to examine both shared and context-specific challenges in applying CE in practice.

2.1 Case descriptions

2.1.1 Case 1: Serious Game Changers. The project explored how co-creating and remixing game-based learning materials could help high school students view themselves as active, creative, and critical co-creators of technology education and digital media. Grounded in CE, it used computer games and remix activities as accessible entry points for reflective, design-oriented engagement with digital tools. Participatory workshops were integrated into ethics and arts classes and aligned with curriculum goals and the UNESCO Sustainable Development Goals (SDG). Co-developed with teachers and partners, the approach was also incorporated into university-level teacher education. Serious Game Changers offered Open Educational Resources, including practical materials and expert videos illustrating how game remixing supports diverse learning objectives.

2.1.2 Case 2: Critical AI Literacy for Generative AI. Combining critical making, critical pedagogy, and value-sensitive design, the work aimed to foster students' critical AI literacy in relation to generative AI. Learners investigated AI as a sociotechnical system shaped by political and value-laden processes, questioning how generative tools are governed and created [19, 20]. Students acted as both civic actors by analyzing media discussing opportunities and harms of generative AI and developing policy proposals and value advocates in design by creating custom GPT-based chatbots with adapted value-sensitive design methods. Activities unfolded in four phases: sensitizing, conceptual inquiry, values-focused ideation and evaluation, and iterative chatbot prototyping with structured reflection.

2.1.3 Case 3: Everyday Computational Empowerment. Focusing on how mobile-first Indian teenagers interpret and shape their everyday digital experiences, the project used CE as a lens to connect youth routines, reflections, and design experiments with participatory design [11, 12]. After collecting examples of daily technology use, researchers collaborated with students to generate lesson plan ideas and creative ways to share insights with peers. Workshop activities mirrored familiar technologies: students built small automations with programmable devices—such as voice-assistant reminders or smart-bulb actions—and paired them with group reflections on habits and digital challenges. These exchanges generated critical reflections on everyday tech. Outputs included youth-authored routines, group reflections, "Fix Alexa" cards, and a co-created lesson plan.

2.1.4 Case 4: Girls Acting for Empowerment. Bridging performative arts and computing education, the work supported young women from marginalized communities in developing critical, creative,

Table 1: Summary of the Five Cases

Case	Location	Context	Duration	Participants
Case 1: Serious Game Changers	Vienna, Austria	Formal education	Three school terms (each comprising 10-20 sessions), totaling about 1.5 years	Four 8th-11th grade groups, each of them formed by 10-30 students aged 13-17 years old. An approximated total of 70 students.
Case 2: Critical AI Literacy for Generative AI	Burnaby, Canada	Formal education	27 90-minute sessions: sessions were thrice a week for nine weeks.	28 students aged 11-13 years coursing 6th and 7th grades, and one school teacher.
Case 3: Everyday Computational Empowerment	Mumbai, India	Non-formal, K12 school and academy	Eight sessions over six weeks, including three co-design sessions.	31 teenagers aged 12–14 with various levels of experience in computing and CT.
Case 4: Girls Acting for Empowerment	Barcelona, Spain	Non-formal, theatre company	15 90-minute sessions arranged during nine months.	10 female students aged 16-18 years and three theatre teachers.
Case 5: Algorithm Auditing Lesson Design	Philadelphia, USA	Non-formal, science center	Two-hour PD workshop in a week-long educator program, and two preparatory sessions.	Three high school teens, six public school teachers, and a science center educator.

and empowered relationships with digital technologies [13]. Emphasizing critical thinking and self-expression, it equipped participants to question technological systems, reflect on gendered norms around access, and strengthen autonomy, confidence, and decision-making. A core focus was challenging restrictive social and family paradigms that limited opportunities in education and technology. Across the sessions, participants explored generative AI and physical computing, reflected on gender and technology, developed a theatre narrative, and prototyped interactive costumes and scenery. Outputs included AI-generated visual concepts, two micro:bit-based prototypes used in the final performance, and an educational framework for future theatre-computing activities.

2.1.5 Case 5: Algorithm Auditing Lesson Design. Designed to help teachers create meaningful algorithm-auditing activities, this initiative combined professional development with youth expertise. Educators were introduced to core auditing practices, carried out small-scale audits to surface bias in generative AI systems, and observed a youth workshop to see how teens interact with algorithmic tools, generating insights they used to draft early lesson ideas [10]. A central element was the Teen Advisory Session, where three high school students acted as expert advisors. Drawing on everyday encounters with social media algorithms, generative AI filters, and informal audits, they refined teachers' concepts to ensure relevance and youth alignment. Outputs included teen-informed feedback, examples of algorithmic bias, and recommendations that strengthened the usability of the emerging lessons.

2.2 Data collection and Analysis

For the data collection and analysis, a template was completed by five different research teams representing the selected cases. The template invited researchers to provide a case description and to reflect on how the case aligns with the commitments outlined in the Manifesto for Computational Empowerment [8], including associated challenges and opportunities for each commitment. Two researchers then reviewed the data and conducted a thematic analysis [1]. This process involved generating initial inductive codes across the dataset, and iteratively refining these through ongoing discussions. The researchers then collated related categories into broader themes, reviewed these against the dataset, and documented them in a shared file. After reaching agreement on the final themes and their presentation, they co-wrote the findings section.

3 Findings

The analysis of the five cases highlights researchers' reflections of the opportunities and tensions that arise when applying the CE Manifesto to guide research and practice. Descriptions of these reflections in relation to each CE manifesto commitment are presented next, with a brief summary provided in Table 2.

Positioning children as co-creators and change agents: The cases show that extending children's roles beyond co-creation requires creating genuine opportunities for real-world impact—such as influencing teaching practices (cases 1, 5), shaping lesson plans (case 3), or engaging wider audiences through public performance (case 4). Such practices can strengthen engagement and ownership, as students feel empowered when their work is meaningful and shared with peers or broader audiences (case 2). They also support reflection and discussion on marginalized perspectives in technology design (cases 2, 3, 4, 5). Associated challenges are linked with contexts and instrumental rationality: positioning children as co-creators and change agents in e.g. after-school contexts may not reflect real-life classroom dynamics and might not be transferable to formal school contexts (cases 4, 5) where institutional school norms restrict student agency (case 2); and introducing utilitarian logics by using commercial GenAI platforms (case 2), restricting genuine possibilities for change.

Nurturing curiosity and critical exploration of digital technologies: Across the cases, hands-on, inquiry-based work with technologies (e.g., AI image generators, chatbots, social media filters, microcontrollers) was combined with critical reflection on

Table 2: Summary of Approaches in Relation to Each CE Manifesto Commitment

	Positioning children as co-creators and change agents	**Nurturing curiosity and critical exploration of digital technologies**	**Fostering care, empathy, and planetary responsibility**
Case 1: Serious Game Changers	Game co-creation and remixing, critical digital authorship, socially engaged design.	Inquiry-based learning, reflective digital experimentation.	Games addressing sustainability challenges.
Case 2: Critical AI Literacy for Generative AI	Analyzing GenAI, designing value-sensitive chatbots, civic and policy engagement.	Exploring GenAI systems, questioning AI values and impacts, iterative experimentation.	Value-based reflection, equity and sustainability evaluation, community responsibility.
Case 3: Everyday Computational Empowerment	Reflecting on digital habits, co-creating digital routines, peer-led practice shaping.	Linking tech with self and world, context-situated exploration.	Tech values awareness, attention to socio-environmental impacts, design for local context.
Case 4: Girls ACTing For EMpowerment	Theater play co-design, lived-experience-based creation, public performance for change.	Physical computing exploration, creativity support via AI prompting, gender-critical tech inquiry.	AI bias and harm awareness, care for privacy and fairness, sustainable creative practice.
Case 5: Algorithm Auditing Lesson Design	Advisory roles, expertise shaping curriculum design.	Algorithm auditing on social media filters, systematic AI deconstruction, algorithmic bias inquiry.	Identification of misgendering harms, collaborative evaluation of AI biases and fairness.
	Supporting children in envisioning and nurturing inclusive futures	**Cultivating hope, aiming for just transformations**	**Promoting frameworks and infrastructures that support CE**
Case 1: Serious Game Changers	Inclusive learning design, imagining various contexts of use.	Recognition of student voice, intergenerational dialogue.	CE-oriented OERs, teacher-multiplier infrastructure, implementation guidelines.
Case 2: Critical AI Literacy for Generative AI	Value-guided imagining, inclusive AI prototyping, policy-based AI future shaping.	Creative engagement for civic agency, democratic AI governance, hope-building civic participation.	Values-based reflection–action frameworks, Critical-pedagogy design infrastructure.
Case 3: Everyday Computational Empowerment	Affirming diverse voices, inclusive tech exploration.	Accessible entry points, skill-building for meaningful impact, design for helping others.	Everyday technology understanding, practical and creative tech use, informed choice and critique.
Case 4: Girls ACTing For EMpowerment	Diverse representations in costume design, AI prompt literacy, gender-sensitive perspective.	Imagining alternative futures, creative computing for confidence, education-to-employment pathways.	Arts–feminist–computing educational framework, principle-based creative computing guidance.
Case 5: Algorithm Auditing Lesson Design	Technical and sociotechnical understanding, problem-based investigation, collective inquiry.	Hands-on demystification of AI systems, independent algorithm exploration.	Structured algorithmic auditing, no technical barriers to investigation.

bias, opacity, and broader socio-technical implications. Activities included critical media analysis (case 2), algorithm auditing (case 5), and iterative design processes, prompting students to question rather than simply use technology (cases 1, 2, 3, 4). Fostering critical explorations of technology created strong opportunities for experiential learning, helping children quickly build technical skills and understanding (cases 3, 4). Connecting to their everyday digital practices also made learning more relevant and meaningful (cases 1, 3, 5). It further supported reflection across different sites and scales of action, linking design with politics (case 2). Significant challenges associated with this commitment point at the difficulty to shift from playful exploration to systemic critique (case 1); classroom time constraints limiting reflection (case 1); and linguistic or conceptual barriers hindering participation (cases 3, 4). Researchers also warned about the tendency to focus on fixing technologies rather than questioning their underlying design assumptions (case 3).

Fostering care, empathy, and planetary responsibility: Across the cases, researchers used CE to guide children's ethical reflection, perspective-taking, and dialogue in computing education connected to real-world issues (e.g., SDGs, sustainability, algorithmic bias, community values). Activities scaffolded ethical thinking through plenary discussions (cases 1, 3, 4), peer-feedback exercises (cases 1, 3), and structured value negotiation (case 2), where students acted as native experts in emerging technologies (case 5). Reported strengths include fostering students' moral engagement by encouraging diverse value perspectives and orienting designs toward broader social concerns (case 2). Peer interaction further supported critical awareness, especially when linked to everyday digital experiences (cases 1, 3). Key challenges stem from limited time for background research, along with consensus pressures, feasibility constraints, and platform limitations, which can lead to superficial discussions or quick convergence on simplistic conclusions (case 1). There is also a need to move from awareness to actionable skills for responsible technological engagement (case 4) and to more explicitly invite

critique and exploration of socio-economic, cultural, and regional contexts (case 3).

Supporting children in envisioning and nurturing inclusive futures: Across the cases, children with diverse skills, languages, identities, backgrounds, experiences, and abilities envisioned futures where they saw themselves as capable contributors to the digital world, shaping future societies and everyday experiences (cases 1–5). Inclusion and diversity featured prominently both in the participating children and in the futures they imagined (cases 1, 2, 3, 4). This commitment fostered a sense of ownership and encouraged critical reflection on technology design, use, and access to it—raising questions about who is included, who is excluded, and why. Children critically engaged with issues of inclusion and exclusion (cases 1, 2, 3), bias and discrimination (case 5), gender-sensitive creative computing (case 4), and the idea of technology as a choice rather than a default (cases 2, 3). However, children's own technology knowledge and experiences influenced how effectively they could challenge these ethical issues (cases 2, 3). Another ongoing challenge was related to embedding critical and ethical perspectives within playful, engaging activities while still supporting meaningful and impactful future-oriented outcomes.

Cultivating hope, aiming for just transformations: Across the cases, participation in research offered children an entry point for questioning the status quo (cases 1, 2, 3), envisioning alternative possibilities (cases 3, 4), engaging in democratic thinking (case 2), developing computational thinking (case 5), and examining technology's impact on themselves and society within a safe, guided environment (cases 2, 3, 5). This commitment empowered children to contribute to research and make their ideas, visions, and hopes visible to wider audiences through activities such as public awareness or art campaigns (case 4), co-designing lessons for peers (cases 1, 3), and sharing policy proposals (case 2). While children's voices directly shaped ongoing research and action, these interventions remain scattered and infrequent. A more sustained framework and community are needed to strengthen their reach and impact.

Promoting frameworks and infrastructures that support computational empowerment: Across the cases, activities combined computational thinking with empowerment (cases 3, 5), bridging performative arts, feminist pedagogy and computing education (case 4) to support critical consciousness, reflection, and action in constructionist projects (cases 2, 3). This commitment underscores the need for strong infrastructural support, including the involvement of diverse stakeholders throughout research and dissemination to create real-world impact. In the cases, researchers co-developed learning materials with children to foster critical engagement with technology (case 1, 3), involved key stakeholders in the research process (cases 1, 5), integrated teacher-training programmes (case 1), and supported high-school students in co-conducting workshops for middle-school learners (case 3). The identified challenges range from power differences between youth and teachers (all cases) to difficulties in transferring insights from informal learning contexts into formal school systems (case 4), with societal structures in form of school schedules and local holidays significantly affecting project timelines in multi-stakeholder collaborations (case 3).

4 Concluding Discussion

This paper serves as an open invitation for the CCI community to reflect on and actively participate in the ongoing development of the manifesto for research on computational empowerment of children [8], and engage with key tensions and possibilities that shape CE. Through our analysis of five diverse cases of computational thinking and CE with children across the world, we showcase how CE is inherently *context-dependent*, (culturally, linguistically, conceptually, socially) *situated*, dependent on *structures* such as local schedules, limited time, and available spaces, materials, and tools supporting or hindering it. Even if the prior literature has already discussed the practical application of CE in different settings (e.g., [14]), it yet remains poorly explored how CE has been interpreted and culturally modified in diverse settings. We acknowledge CE ideals and commitments are culturally translated and embedded within local settings - shaped by participants' lived experiences and situated meanings-making as well as by local histories, values, traditions and epistemologies (see e.g. [15, 17]). Our reflection contributes by shedding light on and appreciating this diversity in CE. We call for future studies that advance exploring the cultural embeddedness of CE in a systematic way, examining its appropriation in diverse socio-cultural-political-economic settings.

A serious aim for CE in positioning children as co-creators and change agents fostering activism, influencing policy, and enabling meaningful behavioral change also challenges both researcher and children's choices and mindsets. It requires moving beyond convenience and easy options to—as seen in our cases—venturing into uncharted territories. On this basis, we propose the following directions to guide further research and practice:

- *Embedding critical and ethical perspectives* within playful, engaging activities while still supporting meaningful and impactful future-oriented outcomes - this could even call for abandoning pleasurable playful exploration of technologies for engaging in serious systemic critique;
- *Acknowledging and examining situatedness and relationality* in making ethical choices;
- *Challenging convenient choices*, like using easily available commercial platforms, or at least transparently critiquing those choices together with children;
- Moving to *questioning the underlying design assumptions* in technologies, looking beneath the surface and asking which pedagogical strategies can bridge this gap by nurturing curiosity and critical exploration of digital technologies;
- *Moving from mere awareness to agency* - to actionable skills and actions for responsible technological engagement - the balance between critique and creativity invites reflection on how educators can scaffold critical consciousness rather than mere engagement; and
- Examining ways to *strengthen reach and impact of children's voices* beyond the 'short-term,' ensuring reciprocity and long-term impact for participants by building infrastructures supporting and sustaining CE. These include teacher training, curriculum integration, and policy support. We ask, what might a truly sustainable CE ecosystem look like in practice?

Bridging the gap between theory and practice requires sustained engagement with children across cultures and contexts to develop a manifesto that is meaningful for the wider CCI community. Therefore, we invite all CCI researchers to explore, examine, critique, and build on our manifesto for research with children on computational empowerment, and seeing the identified challenges indicating paths for future work. We also consider collectively, and openly, reflecting on our challenges as pivotal for our learning and growth as a community.

5 Selection and Participation of Children

Case 1: Serious Game Changers. The project was approved by the ethics committee of the university of Vienna (reference number 00943). Both school officials (school administrators and participating teachers) as well as parents and students were informed about the project and signed a consent form before the workshops began. Workshop site: In the classrooms as well as additional quiet spaces for recording (copy rooms, libraries, etc.) at the three partner schools. The school classes were preselected by the participating teachers based on availability and how well the content aligns with the curriculum of the respective school subjects.

Case 2: Critical AI Literacy for Generative AI. Participants were recruited through a collaborating classroom teacher. Informed consent was obtained from legal guardians and assent from all children prior to the study. Guardians received detailed information about the study, while children were introduced to the project through a presentation. While all students in the classroom took part in the activities as part of their curriculum, they could withdraw from data collection at any time without consequences. Ongoing assent was ensured through regular check-ins, including before recordings, use of artifacts, and participation in interviews. Ethical approval was granted by the institutional and school district review boards.

Case 3: Everyday Computational Empowerment. Research procedures were approved prior to the studies by IIT Bombay (researcher's institution IRB) and the authorities from school (dean, class teachers, computer subject teachers). Workshop site: school classrooms and computer labs. Participation was voluntary, based on availability during the school-approved timings.

Case 4: Girls ACTing For EMpowerment. The conducted research was approved by the institutional ethics boards (IRB) of the two participating universities, University of Lleida and the Open University of Catalonia. Workshop site: Installations of the company Plàudite Theatre – Espai d'Arts Escèniques. Participation was voluntary and the participants were selected by the theatre company and a collaborating school within the #ACTFEM programm.

Case 5: Algorithm Auditing Lesson Design. We recruited teens already enrolled in a STEM program at a science center in a city located in the Mid-Atlantic United States. The teens were invited by the organizer of the STEM program to participate via email. Parents received consent forms prior to the study, which included a brief explanation of the research, and the teens assented to their participation. Research protocols and data collection methods were approved by the IRB board of the University. Teens received hourly compensation for their time as well as meals during sessions.

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