Journal of Inclusive Methodology and Technology in Learning and Teaching
ISSN 2785-5104
Anno 5 n.3 (2025)

EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

Teachers, Multigrade Classes and Technological Imagination: Reflective Scenarios for a Pedagogy of the Future

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Abstract: Small and multigrade schools offer a distinctive perspective for examining the digital transformation of education. Situated in rural or peripheral areas, they expose both the promises and contradictions of technological innovation in non-standard contexts. This study explores how Italian teachers working in multigrade classrooms imagine the pedagogical role of digital technologies, interpreting imagination itself as a form of situated professional knowledge. A national questionnaire conducted by INDIRE in 2024–2025 collected 1,061 responses, including an open-ended item inviting teachers to envision an ideal technology for their entire class. Ninety-seven narratives were selected for their conceptual richness and analyzed through qualitative content analysis supported by reflexive dialogue with a generative AI model used as an interpretive partner. The analysis revealed six macro-visions of technology converging into three interpretive postures—care, orchestration, and creativity—which express ethical, organizational, and design-oriented ways of reimagining teaching in multigrade settings. Teachers envision technologies that extend rather than replace professional judgment, emphasizing relational proximity, visibility of learning processes, and collaborative creation. By linking technological imagination, multigrade pedagogy, and teacher professional agency, the study highlights how imaginative reflection becomes a resource for rethinking digital innovation in small and rural schools.

Keywords: technological imagination; multigrade classrooms; teacher professional agency

1. Digital Technologies, Small Schools and Multigrade Teaching

In the contemporary discourse on educational innovation, small schools and multigrade classrooms provide a unique analytical lens through which to interrogate the meaning, scope, and sustainability of the digital turn in education. These contexts—frequently situated in rural, insular, or mountainous areas—bring into sharp relief many of the systemic tensions that digitalization claims to resolve geographic isolation, fragmentation of learning time, limited access to resources, and the enduring

[1] Authorship attribution: Francesca De Santis is the author of Sections 2 (*Research Design and Methods*) and 3 (*Results*). Giuseppina Rita Jose Mangione is the author of Sections 1 (*Digital Technologies, Small Schools and Multigrade Teaching*), 4 (*Discussion*), and 5 (*Conclusions*)

challenge of designing inclusive and adaptive learning environments. Yet, far from being passive recipients of innovation, small schools constitute epistemic sites where the relationship between technology and pedagogy can be critically re-examined. They remind us that educational technologies are never neutral instruments but cultural artefacts whose design, interpretation, and use are embedded in local ecologies of meaning.

Small schools are not simply smaller versions of large institutions; they represent distinct pedagogical ecologies. Their reduced scale fosters proximity, continuity, and intergenerational learning, features that are often undermined in the standardized rhythms of urban schooling (Mangione & Cannella, 2021). The daily practices of teachers in these environments demand flexibility and improvisation; teaching becomes a living negotiation between stability and change. Within this ecology, the multigrade classroom — where pupils of different ages and levels share the same space — acts as a condensed model of educational complexity. What might appear to be a logistical constraint reveals itself as a powerful engine of pedagogical invention. The teacher must design multilayered trajectories, balance individual and collective goals, and orchestrate rhythms of learning that are both differentiated and shared.

This pedagogical complexity resonates strongly with the opportunities and risks of digital education. Over the last decade, digital technologies have been heralded as key enablers of innovation in peripheral contexts: tools capable of expanding teaching time through asynchronous modes, personalizing instruction through adaptive algorithms, and bridging distance through networked communication (Mangione, 2023). From virtual classrooms to online communities of practice, technology has been envisioned as the catalyst that could turn small and multigrade schools into "connected schools of the future." Yet empirical evidence remains ambivalent. Studies conducted in Italy and internationally show that while access to digital devices has increased, the pedagogical integration of these tools is still inconsistent and frequently instrumental (Mangione, 2024). In many multigrade schools, digital equipment is limited to interactive whiteboards and basic devices, while more transformative tools—robotics, AI-based platforms, immersive or mixed-reality environments—are rare and often employed in pilot projects rather than mainstream practices (Mangione, Pieri, & De Santis, 2024).

This discrepancy between technological availability and pedagogical transformation reveals that the central challenge is not material scarcity but pedagogical translation. Technologies acquire educational meaning only when reinterpreted within a living system of relationships that link teachers, learners, communities, and territories. As Beetham and Sharpe (2019) contend, learning technologies do not shape education from the outside; rather, they become educational when embedded in social and cultural practices. In small schools, this embedding is inseparable from the rhythm of the community itself: slow, relational, and deeply place-based. A technology introduced without sensitivity to these temporal and social dimensions risks replicating the same hierarchies and standardizations it purports to disrupt.

Recent work within the National Network of Small Schools (INDIRE) demonstrates that the success of digital innovation in peripheral contexts depends on the degree to which technologies embody the principle of digital proximity — a notion that redefines connectivity not as mere technical access but as relational closeness (Mangione, 2024). Through locally co-designed projects such as hybrid classrooms, community-based digital ateliers, and online inter-school collaborations, these initia-

tives illustrate how technology can serve as a medium for educational continuity rather than mere digital substitutions. Within these projects, technology supports teachers' professional networks, links families to school life, and enables collective storytelling across dispersed territories. In this sense, small schools are becoming laboratories of digital flourishing: environments where technology sustains cultural vitality, civic participation, and pedagogical creativity despite infrastructural fragility.

The concept of digital flourishing (Mangione, 2024) reframes the notion of digitalization from a purely functional process into a cultural and ethical horizon. Flourishing implies not only access and competence but also the capacity of schools to appropriate technology as a means of self-development and communal growth. In non-standard educational contexts—those characterized by multigrade teaching, demographic fragility, and territorial dispersion—flourishing manifests when digital ecosystems foster belonging, creativity, and resilience. This perspective shifts the discourse from "technology for inclusion" to "technology through relation," emphasizing that innovation is sustainable only when it reinforces the fabric of social and pedagogical interdependence that defines small schools.

At the micro-level of classroom practice, digital media have opened new spaces for reconfiguring knowledge and learning in multigrade environments. They enable students to access distributed resources, to collaborate asynchronously, and to co-create multimodal artefacts that amplify their voices within and beyond their communities. These practices illustrate the pedagogical potential of what could be termed networked imagination: the ability of teachers and learners to transform limited technological resources into open learning ecologies. When aligned with the cooperative ethos of multigrade pedagogy, technology becomes a vector of cultural resilience—a way to preserve local identities while engaging with global discourses. This aligns with the broader notion of education for sustainable development, which views schools as agents of territorial vitality and innovation (OECD, 2020).

Nevertheless, such potential is not automatic. Without adequate professional support, digitalization can intensify the fragility of small schools by increasing teachers' workload, reinforcing dependency on unstable infrastructures, and narrowing the space for pedagogical judgment. The literature documents persistent asymmetries between policy rhetoric and actual conditions on the ground (Parigi, Mangione, & De Santis, 2023). Despite targeted national initiatives and investments, professional development programs often focus on generic ICT skills rather than on the context-sensitive pedagogies required for multigrade teaching. An INDIRE national survey (2023–2024) involving more than a thousand teachers found that only 8 percent had received specific training in multigrade methodologies, although most reported confidence in using digital tools. This gap highlights a fundamental paradox: teachers are equipped with devices and competencies but not with the pedagogical frameworks needed to translate these resources into situated innovation.

Addressing this paradox requires re-conceiving professional development as a co-design process rather than a top-down transmission of skills. In the most promising examples within the Small Schools Network, teachers engage in participatory design of digital resources, collaborate across institutions, and contribute to research–practice partnerships that generate locally valid knowledge (Mangione, 2024). These practices suggest that professional agencies emerge when teachers are recognized as designers of innovation, not merely its end-users. Their capacity to imagine

and prototype technological solutions for their unique contexts—what this study defines as technological imagination—is thus a critical driver of sustainability.

From this perspective, the small and multigrade school ceases to be a marginal site of educational policy and becomes a strategic epistemic laboratory for the digital transition. It exposes the limits of models that equate innovation with scale, automation, and standardization. It challenges the assumption that effective digitalization requires large infrastructures or uniform pedagogies. Instead, it demonstrates that innovation can thrive through minimal resources, provided these are supported by dense relational networks and reflective professional cultures. In this sense, small schools are not the "last frontier" of digital inclusion but the first frontier of sustainable innovation, where the material and symbolic dimensions of technology are continuously re-negotiated.

At a theoretical level, this approach invites a re-definition of what counts as sustainability in educational technology. Sustainability should not be reduced to financial endurance or environmental efficiency; it must be understood as pedagogical coherence, the ability of technologies to sustain human relationships and cultural diversity within educational systems. For small schools, this means tools that operate across fluctuating connectivity, accommodate asynchronous rhythms, and reinforce the teacher's interpretive centrality. For policy makers, it means designing frameworks that value adaptability and local creativity as much as technical performance.

Ultimately, the intersection of small schools, multigrade teaching, and digital innovation offers an opportunity to rethink the epistemology of educational technology itself. Instead of viewing technology as an external catalyst for modernization, we can regard it as an internal dimension of pedagogical ecological living component of how teachers and learners make sense of their world. In this view, technologies are not ends in themselves but mediators of meaning, instruments through which education negotiates its own continuity in conditions of change.

The present research situates itself within this critical horizon. By examining how Italian teachers working in multigrade settings perceive and project the role of digital technologies, it seeks to reveal how technological imagination functions as both a reflective and generative competence. Teachers' imaginative scenarios do not merely describe the future; they construct it symbolically, articulating what kinds of relationships, practices, and values should shape the educational futures of small schools. Through their visions, we can glimpse a form of digital innovation that is neither imposed nor accidental, but consciously crafted—a form of flourishing rooted in community, sustained by reflection, and directed toward the ethical renewal of teaching.

2. Research Design and Methods

This study is part of a broader national investigation promoted by INDIRE in 2024–2025. It aims to explore teachers' representations and digital practices in multigrade classrooms in Italian primary and lower secondary schools. The questionnaire included 25 items and used a mixed-methods approach. One open-ended question invited teachers to imagine a didactic activity for the entire multigrade class, supported by advanced technology, even one that did not yet exist. This prompt functioned as an anticipatory device (Facer, 2019). It activated discursive forms of desire, fear, and vision about the future of multigrade teaching. Following a situated epistemology

perspective (Haraway, 1988; Mortari, 2003), imagining an ideal technology was interpreted as part of a professional meaning-making rooted in lived experience.

The questionnaire collected 1,061 total responses. Of these, 277 answers to the open-ended item were excluded because they were incomplete or not relevant to the prompt. The remaining 784 valid responses underwent an initial macro-level thematic analysis. This analysis identified, for each text, the pedagogical purpose, the type of technology mentioned, and the corresponding technological scenario (S1 – consolidated; S2 – emerging; S3 – visionary). This preliminary mapping outlined the general trends of the corpus (De Santis & Mangione, 2025) and provided the basis for choosing 97 texts. These were selected for their narrative richness, conceptual density, and relevance to the multigrade context.

Only texts containing at least 80 words were included, as this threshold was considered necessary to facilitate the emergence of articulated pedagogical visions and reflective tensions. This cut-off was adopted to guarantee sufficient narrative density and comparability across texts, minimizing very short descriptive responses that offered limited interpretive value. Additional filter retained only responses referring to *"emerging"* or *"visionary"* scenarios, thereby prioritizing those capable of anticipating practices or redefining processes. Direct relevance to the multigrade context was also verified, with inclusion limited to texts explicitly addressing issues such as age and level heterogeneity, time management, and group organization. The selection process did not seek statistical representativeness but instead followed a logic of maximizing conceptual variety (Patton, 2002). Each response was treated as a micro-case exemplifying a possible conception of the relationship between technology and multigrade pedagogy.

The analysis adopted a qualitative, interpretive-constructivist approach (Creswell & Poth, 2018; Mayring, 2021), aimed at exploring teachers' representations as contextually situated meanings rather than objective variables. The rereading of the corpus, which contained 97 texts already coded according to the dimensions of pedagogical vision, value axes, and educational tensions, aimed to elicit latent meanings within the teachers' narratives. Each text was treated as a complex discursive unit, exploring meanings, metaphors, and lexical choices indicative of the underlying pedagogical postures. Two iterative rounds of researcher discussion ensured inter-coder reliability. Coding decisions were reached by consensus, and all analytical steps were documented through reflective memos and successive versions of the codebook. A distinctive feature of the process was the utilisation of the ChatGPT-4o generative model as a reflective partner. The employment of AI was not for the purpose of automating coding processes; rather, it functioned to stimulate alternative perspectives and to foster critical dialogue between the researchers. The model functioned as an epistemic mirror, serving to both reflect and amplify awareness of interpretive biases, and to support reflexive triangulation (Holmes et al., 2024). This was achieved using targeted questions and suggestions for grouping. The procedure was conducted in three successive stages:

1. Exploratory rereading – Identification of key images and semantic nuclei (e.g., care, orchestration, creativity, control) through exploratory prompts.
2. Construction of the interpretive code – Refinement of emerging labels into a shared analytical framework through comparative prompts.

3. Reflective synthesis – Development of three interpretive trajectories, technologies as allies of care, systems of orchestration, and spaces of creative design, supported by reflective prompts.

Table 1. Examples of prompts used in the analytical process

Type of prompt	Methodological purpose	Examples of prompts to the model
Exploratory	To surface recurrent images or metaphors	"Which metaphors or recurring images emerge in these descriptions of educational technologies?"
Comparative	To verify semantic similarities across responses.	"Suggest synthetic categories that might connect these responses."
Reflective	To stimulate meta-reflection on interpretive biases.	"What alternative readings might plausibly emerge from this text?"

The model's outputs were discussed and critically evaluated by both researchers, with human decision-making fully retained throughout. The entire process was documented through coding notes, intermediate category versions, and reflective comments on interpretive shifts. This technological hybridization enhanced the reflexivity of the analysis.

The methodology thus becomes a locus of learning, not merely a set of procedures but an epistemic laboratory in which the coexistence of human and artificial intelligence is explored in the production of educational knowledge. The research itself emerges as a speculative and responsible practice, aimed at understanding how technologies can act not only in schools but also on educational research, expanding its spaces for inquiry and imagination. Because the selection privileged narrative richness and conceptual variety, the resulting corpus constitutes a *theoretical sample* rather than a statistically representative one. Following Patton's (2002) notion of theoretical sampling, the aim was to maximize conceptual diversity and to explore emerging categories, rather than to achieve representativeness.

3. Results

3.1. From Data to Posture: the Process of Interpretive Construction

This section presents an interpretive reading of teachers' technological imagination, conceived not as an analytical datum but as a form of pedagogical knowledge. The micro-analysis of the 97 selected texts revealed six macro-visions of technology use in multigrade classrooms: Relational-Mediative (26%), Instrumental-Regulative (25%), and Creative-Projective (20%), followed by Technocentric-Automating (13%), Inclusive-Emancipatory (9%), and Managerial-Efficientist (7%).

These visions describe different functions of technology, from relational support to process automation, without, however, exhausting its value-laden and reflective dimensions.

Table 2. Overview of the six macro-visions of technology in multigrade teaching

Macro-Vision	Description
Relational-Mediative	Technology as a mediator of educational relationships, facilitating collaboration, peer tutoring, and the construction of learning communities.
Instrumental-Regulative	Technology as an organizational and operational aid for planning, monitoring, and managing activities, time, and materials.
Creative-Projective	Technology as an enabler of design and production, supporting the creation of artefacts, exploration, and multimodal storytelling.
Inclusive-Emancipatory	Technology as a lever for access and equity, reducing linguistic, sensory, or organizational barriers.
Technocentric-Automating	Technology as a substitutive automation, with systems that make decisions or deliver instruction in place of the teacher.
Managerial-Efficientist	Technology to optimize educational time, workload, and resource flows.

A phenomenological rereading, supported by exploratory prompts and researcher dialogue, identified three transversal semantic patterns: *care* (54 texts – keywords such as listening, helping, trust, support); *orchestration* (51 texts – keywords such as coordination, monitoring, tracking); *creativity* (49 texts – keywords such as co-construction, storytelling, learner protagonism). The six macro-visions identified through the qualitative analysis converge into three interpretive postures of technological imagination. Each posture expresses a distinct yet interconnected way in which teachers envision the pedagogical role of technology in multigrade classrooms.

Table 3. Relationship between macro-visions and interpretive postures

Interpretative Posture	Associated Macro-Visions	Core Meaning
Technologies as allies of caring	Relational-Mediative; Inclusive-Emancipatory	Technology as an ethical and relational extension of teaching, supporting inclusion and attention to learners' needs without replacing human empathy.
Technologies as systems of orchestration	Instrumental-Regulative; Managerial-Efficientist	Technology as a tool for coordination, monitoring, and distributed attention — making complexity visible while maintaining teacher control.
Technologies as spaces of creative design	Creative-Projective; Relational-Mediative	Technology as a medium for collaborative creation and multimodal expression, transforming heterogeneity into epistemic capital.

3.2 Technologies as Allies of Caring

The posture of care emerges from the intersection of the Relational-Mediative and Inclusive-Emancipatory visions, in which technology is conceived as an ethical and relational extension of the teacher's action.

Many teachers imagine tools capable of "*reading students' needs and returning time to the teacher for relationships*" or environments that "*adapt materials to competence levels so that everyone can actively participate*".

These representations embody the principles of the ethics of care (Noddings, 1984; Mortari, 2015). AI is envisioned as an auxiliary presence, a "third ear" that helps teachers perceive subtle signals and personalize their attention.

However, this trust in augmented care is not free from ambivalence. In some texts, the posture intertwines with the Instrumental-Regulative vision: the platform "*suggests which students need help to the teacher*" or "*tracks individual progress to enable timely intervention*", thus risking a form of algorithmic care mediated by automation.

Other cases shift the focus from individual care to collective care: "*Students help each other, and the teacher observes their progress to intervene when needed*". Here, care becomes a communal practice, and technology a space for supportive interaction. The posture of care thus acquires the meaning of relational personalization: digital innovation supports educational closeness without replacing the teacher.

Yet crucial questions remain: to what extent can understanding the other be delegated to an algorithm? What remains of the relationship when contact is mediated by sensors and data? In this perspective, technology becomes a moral mirror of professional teaching: it promises proximity but simultaneously tests its limits.

3.3 Technologies as Systems of Orchestration

The posture of orchestration is rooted primarly in the Instrumental-Regulative and Managerial-Efficientist visions, introducing a reflective dimension of pedagogical governance. Technology is imagined as a control room, enabling teachers to manage time, groups, and activities within the complexity of multigrade classrooms. One teacher writes: "*A virtual assistant that monitors progress, suggests personalized materials, and facilitates collaboration*". Another imagines: "*A panel showing who is working and who needs help, so that no one is left behind*".

These narratives resonate with the concept of didactic orchestration (Laurillard, 2012; Luckin, 2018): making learning processes visible to distribute the teacher's attention more equitably.

However, technological orchestration moves along an ambiguous line: it amplifies instructional awareness but may also drift toward surveillance and evaluative delegation. In the more technocentric cases, orchestration verges on automation, the teacher observes but no longer decides, replaced by a system that interprets on their behalf. Conversely, some Relational-Mediative narratives reinterpret orchestration as distributed attention: "*Technology coordinates the work, but I choose how to adapt the learning paths, it helps me see better, not to command*".

The challenge lies between assistive orchestration and substitutive orchestration. In the first case, technology amplifies pedagogical awareness; in the second, it reduces reflection to a logic of automation. Within this delicate balance lies the possibility of a pedagogically sustainable orchestration: a system that coordinates without deciding in place of the teacher.

3.4 Technologies as Spaces of Creative Design

The posture of creativity combines the Creative-Projective and Relational-Mediative visions: technology serves as both a cognitive partner and a dialogical material. It shifts the teacher's imagination from mediation or management toward generative experience: a space of co-creation where knowledge is built through narration, experimentation, and collective production.

Teachers imagine environments where students co-construct digital artefacts: "*In the digital storytelling lab, students create illustrated stories: older pupils write, younger ones draw, and the platform reads aloud to support those with learning difficulties*". Or: "*A technology that creates a fairy tale with the children's voices, so they feel like protagonists*".

The multigrade class thus becomes a cognitive atelier, where age became epistemic resources: "*The older one's guide, the younger ones inspire, and the platform mediates their collaboration*".

In some Inclusive-Emancipatory responses, creativity takes on the meaning of democratic agency: "*Everyone contributes according to their abilities, and the final product represents the class as a whole*". This envisions creativity not as an individual talent but as a shared, negotiable practice.

Nevertheless, some Instrumental-Regulative or Technocentric cases describe guided creativity: "*The technology proposes story or image templates, and students choose which to develop*", risking a form of standardized imagination.

Overall, the posture of creativity expresses a pedagogy of possibility—imagining what does not yet exist as an act of professional agency, where technology extends but does not replace human creation.

4. Discussion: Interpretation and Implications of the Results

This section interprets and problematizes the findings of the study through the theoretical and epistemological lenses that informed its design. The discussion is articulated into six interconnected thematic areas that together illuminate how teachers' technological imagination in multigrade contexts expresses both professional reflection and anticipation of educational futures.

Rather than following a purely descriptive order, the discussion unfolds through progressive layers of meaning: from the situated nature of teachers' imaginative projections, to the ethical and relational ambivalences of digital care, the governance of complexity through technological orchestration, the creative redefinition of heterogeneity, the epistemological implications of integrating artificial intelligence as a reflective partner in research, and finally the sustainability and prospective directions emerging from these imaginaries. Authors should discuss the results and how they can be interpreted from the perspective of previous studies and of the working hypotheses. The findings and their implications should be discussed in the broadest context possible.

4.1. Technological Imagination as Situated Professional Knowledge

The analysis demonstrates that teachers' imagined technologies are not abstract fantasies, but forms of situated professional knowledge generated within the lived complexity of multigrade classrooms. The 97 selected narratives, chosen for their conceptual richness rather than representativeness, function as a theoretical sample in

the sense proposed by Patton (2002): each text exemplifies a unique intersection of experience, context, and pedagogical intent.

In these accounts, imagination becomes an epistemic act that allows teachers to rehearse possible futures and to reinterpret their professional identity under the pressures of structural isolation, resource scarcity, and heterogeneous student groups. Following Haraway's (1988) notion of *situated knowledges*, these imaginaries are partial yet accountable constructions of meaning, revealing teachers' desire to reconcile the constraints of their practice with the promise of digital transformation.

The imagined technologies express expectations rather than descriptions: they are tools for time recovery, relational presence, orchestration, and collaborative creativity. Thus, technological imagination operates as an anticipatory discourse—a way of producing pedagogical knowledge through speculation, where envisioning becomes a method for rethinking teaching itself.

4.2 Ambivalences of Digital Care: Ethics and Responsibility

The posture of care, present in 54 of the analyzed texts, is the most emotionally and ethically charged. Teachers imagine intelligent systems capable of reading students' needs, mediating group work, or personalizing materials so that "everyone can participate." These scenarios extend the *ethics of care* (Noddings, 1984; Mortari, 2015) into digital form, redefining empathy and attention through mediated presence.

However, the same technologies that promise proximity also risk reconfiguring care into automation. When the interpretation of the learner's needs is delegated to an algorithm, care shifts from a dialogical to a procedural act—a process of *algorithmic empathy* that simulates understanding rather than cultivating it. This tension exposes the ethical limits of delegation: relational attention can be supported but never replaced.

From the perspective of pedagogical sustainability, the findings underline that teachers envision technology as an ally of human sensitivity, not a substitute for it. Sustainable innovation in multigrade contexts must therefore preserve the *interpretive agency* of the teacher, ensuring that technological mediation enhances rather than erodes the ethical responsibility that defines educational relationships.

4.3 Orchestrating Complexity: Visibility, Governance, and Tension

The posture of orchestration, emerging from 51 narratives, reflects teachers' aspiration to render the multiplicity of learning processes in multigrade classrooms visible and governable. Imagined tools include dashboards that display real-time progress, virtual assistants that monitor group work, and adaptive systems that propose personalized materials. These visions echo Laurillard's (2012) and Luckin's (2018) conception of teaching as didactic design and orchestration—a process of harmonizing diverse learning trajectories. Yet within this vision lies a tension between empowerment and surveillance. Technological orchestration enhances teachers' awareness but also threatens to codify it into data-driven routines. When systems observe, record, and suggest, there is a risk that human judgment becomes dependent on algorithmic interpretation. The findings thus call for a distinction between assistive orchestration, which amplifies awareness, and substitutive orchestration, which diminishes it.

In multigrade contexts, where one teacher often manages multiple age groups and curricular strands, sustainability depends on technologies that coordinate without deciding. A truly sustainable orchestration system must make complexity visible without reducing teaching to procedural oversight. The teachers' imaginaries articulate this demand clearly, offering an implicit critique of technocentric models that equate efficiency with pedagogical quality.

4.4. Creativity as an Ecology of Co-Construction

The posture of creativity, expressed in 49 narratives, projects technology as a medium for collective creation and meaning-making. Teachers describe digital storytelling environments, virtual ateliers, and multimodal laboratories in which pupils of different ages contribute according to their abilities. The multigrade class is reimagined as a cognitive atelier where heterogeneity becomes epistemic capital: older students guide, younger ones inspire, and technology mediates the process of co-authorship.

This posture embodies a pedagogy of possibility: by imagining technologies that do not yet exist, teachers assert their agency to shape future forms of learning. Creativity here functions not merely as an outcome but as a method of professional reflection—a space where design and pedagogy converge. Nevertheless, some narratives reveal the shadow of standardized creativity, in which templates or automated suggestions constrain the freedom of expression. The data suggests that creative sustainability requires *low-threshold, high-expressivity technologies*: tools that can function in low-resource environments while supporting rich, participatory, and multimodal forms of learning.

The creative posture thus defines an ecological approach to innovation—where sustainability is measured by the capacity to generate shared meaning rather than by technological sophistication alone.

4.5 *The Research Process as an Epistemic Laboratory*

A distinctive contribution of this study is its methodological experimentation with generative artificial intelligence (ChatGPT-4o) as a reflective partner in data analysis. The model was not used to automate coding but to stimulate alternative readings and to make interpretive biases explicit. This aligns with recent reflections by Holmes, Porayska-Pomsta, and Holstein (2024) on *teaching with and about AI*, which advocate using AI as a dialogical and metacognitive instrument rather than as a replacement for human expertise.

From an epistemological standpoint, the integration of AI transformed the analytic process into an epistemic dialogue between intelligences—a human–machine interaction oriented toward reflexivity and transparency. All interpretive decisions remained human and were systematically documented through coding notes and reflective commentaries.

This methodological hybridization illustrates how educational research itself can become a laboratory of coexistence between human and artificial intelligence. It demonstrates that sustainability in research practice does not depend solely on efficiency but on preserving interpretive depth and ethical accountability while expanding methodological imagination.

4.6 Sustainability and Future Directions for Multigrade Innovation

The speculative character of the corpus, focused on "emerging" and "visionary" scenarios, invites reflection on the gap between pedagogical desirability and practical feasibility. Many of the imagined technologies presuppose infrastructure, data integration, and teacher training that are not yet available in the rural and small-school contexts where multigrade classes typically operate. Teachers' imaginaries thus act as aspirational diagnostics: they articulate what professionals consider pedagogically necessary rather than what is currently possible. In this sense, the findings contribute to a redefinition of sustainability in educational technology. Sustainability must be understood not only in economic or environmental terms, but as pedagogical coherence—the alignment between technological design, contextual realities, and human values. Based on the data, three directions emerge for future policy and research:

1. Relational time – design technologies that free rather than fragment teachers' attention, reinforcing relational pedagogy;
2. Transparent orchestration – develop analytic systems that are interpretable, optional, and supportive rather than prescriptive;
3. Collaborative creativity – promote inclusive tools enabling co-construction of learning artifacts across age and ability levels.

Future studies could translate these imaginaries into participatory design experiments, where teachers and researchers collaboratively prototype and test tools in real multigrade classrooms. Such experimentation would transform imagination into a method of responsible anticipation, positioning multigrade schools not as marginal spaces but as laboratories for sustainable educational futures.

5. Conclusions

This study explored how teachers in multigrade classrooms imagine the role of technology in their pedagogical futures, revealing that imagination itself constitutes a form of professional knowledge and ethical reflection. Rather than depicting tools or functions, the teachers' narratives project values, aspirations, and critical tensions that define the horizon of sustainable innovation in education.

Three interpretive postures—care, orchestration, and creativity—emerged as distinct yet interwoven expressions of how teachers negotiate the relationship between technology and pedagogy. These postures are not fixed categories but dynamic stances that show how professional agency operates within conditions of constraint. Together, they outline an alternative epistemology of digital education: one grounded in relational ethics, reflective governance, and collective creativity.

Methodologically, the research demonstrated that qualitative inquiry can benefit from a dialogical engagement with artificial intelligence when used as a reflective rather than automatizing partner. This experience positions the research process itself as a space of co-learning, where human and artificial intelligences coexist in the production of meaning without eroding interpretive responsibility.

From a broader perspective, the findings invite a rethinking of sustainability in educational technology. Sustainable innovation in multigrade schools cannot be measured solely by access to digital infrastructure or by efficiency gains, but by the capacity of technology to strengthen the pedagogical core of teaching—time for relationships, visibility of learning processes, and opportunities for shared creation.

Future research should therefore move from imaginative speculation to participatory experimentation, co-designing with teachers and learners to test how these envisioned tools can function in real contexts. By doing so, multigrade classrooms—often seen as peripheral—can become pivotal laboratories for reimagining the future of inclusive, ethically grounded, and context-sensitive education.

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