Journal of Inclusive Methodology and Technology in Learning and Teaching
ISSN 2785-5104
Anno 6 n. 1 (2026)

EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

Collective Intelligence, Connective Intelligence and Artificial Intelligence: Methodological Implications for Educational Research

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Abstract: This article offers a critical examination of the concepts of collective intelligence, connective intelligence and artificial intelligence, exploring their epistemological, methodological and ethical implications for contemporary educational research. Drawing on theories of distributed cognition and media ecology, the paper brings into dialogue the perspectives of Pierre Lévy and Derrick de Kerckhove, highlighting how knowledge increasingly emerges from networks of relationships among individuals, social practices and technological infrastructures. Within this framework, generative artificial intelligence is interpreted not as a substitute for human thinking, but as an epistemic artefact capable of supporting learning, provided that its use is mediated through critical pedagogical practices. The risks associated with technological determinism and the illusion of understanding produced by the immediate availability of automated responses are critically examined, emphasising the central role of reflective, critical and ethical competences. Particular attention is devoted to issues of data ethics, privacy and responsibility in the management of educational information. From a methodological standpoint, the paper argues for a reconfiguration of educational research in participatory, collaborative and multi-method terms, foregrounding approaches such as action research, design-based research and digital ethnography. The article concludes by advocating for a critical and human-centred educational paradigm, capable of orienting the use of intelligent technologies towards the shared and conscious construction of knowledge.

Keywords: Collective intelligence; Connective intelligence; Artificial intelligence in education; Educational research methodologies; Data ethics

[1] The papaer is the result of scientific collaboration between the authors; however, authorship is attributed as follows: Maria Chiara Marciano is the author of the paragraphs 3.Generative artificial intelligence: support or substitute? 4.Data ethics and responsibility in information storage. 6.Critical education in the age of AI: perspectives and practices; Giovanni Arduini is the author of the paragraphs 1. Introduction: From media culture to digital pedagogy. 2.Collective intelligence and connective intelligence: two perspectives in dialogue. 5.Methodological implications for educational research. 7.Conclusion: towards a conscious, critical and human-centred educational research.

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1. Introduction: From media culture to digital pedagogy

Contemporary educational research is confronted with an epochal challenge: understanding and interpreting the complex interaction between the human mind, digital technologies and distributed cognitive processes. Collective intelligence, connective intelligence and artificial intelligence are not merely abstract theoretical constructs; rather, they describe concrete dimensions of contemporary knowledge production (Lévy, 1994; de Kerckhove, 1997; Russell & Norvig, 2021). These paradigms call for a substantial rethinking of educational research methodologies and stimulate critical reflection on the role of technology in knowledge construction and in the education of future generations. Addressing this challenge requires moving beyond a narrow focus on technological innovation to interrogate the ways in which knowledge emerges, circulates and becomes entangled with subjectivities, social practices and institutional contexts.

Media culture has long provided a fertile ground for such reflection. Marshall McLuhan's well-known dictum, "the medium is the message", encouraged scholars to conceptualise technology not as a neutral tool, but as a cognitive environment capable of shaping perception, language and thought (McLuhan, 1964). Derrick de Kerckhove, extending McLuhan's insights into the digital domain, introduced the notion of connective intelligence, understood as a form of cognition emerging from the interaction between individuals, devices and networks (de Kerckhove, 1997). Within this perspective, knowledge is no longer localised within an individual subject, but distributed across networks of interpersonal and technological relations that redefine learning and modes of being in the world.

In parallel, artificial intelligence (AI)—understood as a set of systems capable of learning from data, processing information and generating complex outputs—has profoundly reshaped expectations surrounding education (Russell & Norvig, 2021; UNESCO, 2022). In particular, the emergence of generative AI systems capable of producing texts, images and simulations has opened unprecedented possibilities for supporting teaching and learning processes. At the same time, these developments raise fundamental epistemological and ethical questions: what does it mean to know in an algorithmically mediated environment? How is knowledge constructed? What role does the human subject play within an increasingly hybrid and distributed cognitive ecosystem (Stiegler, 2010; Floridi, 2016)?

A recurring risk in this debate is technological determinism, namely the assumption that technologies, by virtue of their intrinsic properties, inevitably shape learning processes and social structures. The work of McLuhan and de Kerckhove suggests otherwise: while technologies function as media and cognitive environments, their actual impact depends on interpretative practices, critical appropriation and pedagogical design (McLuhan, 1964; de Kerckhove, 1997).

The central limitation of technological determinism lies in the belief that innovation alone can resolve educational or social challenges without sustained pedagogical mediation. Although AI can support learning processes, the construction of conceptual coherence, deep understanding and critical re-elaboration remains a distinctly human endeavour. AI systems generate data, patterns and syntheses; human intelligence transforms these into knowledge, culture and reflective awareness.

Theories of distributed cognition have contributed to overcoming the notion of an isolated mind by conceptualising intelligence as emerging from the interaction between individuals, artefacts and contexts (Hutchins, 1995). Within this theoretical framework, Pierre Lévy's concept of collective intelligence describes the capacity of communities to think and act in coordinated ways through communicative and co-operative processes (Lévy, 1994). Collective intelligence does not simply represent the aggregation of individual competences, but an emergent, dynamic and situated form of knowledge. Digital technologies, and the Internet in particular, have amplified these dynamics, enabling the formation of global, networked knowledge communities.

From a methodological perspective, this paradigm invites educational research to privilege participatory, collaborative and qualitative approaches capable of capturing the relational and processual nature of learning. Methodologies such as action research, design-based research and digital ethnography are especially well aligned with this epistemological orientation.

Against this background, the present contribution aims to critically examine collective and connective intelligence within a broader theoretical framework, to assess the opportunities and limitations of artificial intelligence, and to explore the ethical and methodological implications of intelligent technologies in education. By placing different perspectives in dialogue, the paper seeks to outline how educational research can respond to the epistemic and normative challenges of an increasingly connected and digitalised world (Barab & Squire, 2004; Kemmis et al., 2014; Pink et al., 2016).

2. Collective intelligence and connective intelligence: two perspectives in dialogue

The concept of collective intelligence originates in studies of distributed cognition and communities of practice, describing the capacity of a group to generate knowledge and solutions that exceed what any individual could achieve alone (Lévy, 1994; Hutchins, 1995). Pierre Lévy defines collective intelligence as an "intelligence that is realised within a space of collective subjects that is not predetermined, but continuously constructed through communicative processes" (Lévy, 1994). Within this framework, the Internet plays a pivotal role by enabling the aggregation, negotiation and systematisation of distributed knowledge on a global scale (de Kerckhove, 1997).

Collective intelligence cannot be reduced to the mere sum of individual competences; rather, it constitutes an emergent, dynamic and situated form of knowledge. Digital technologies have significantly amplified these processes, fostering the development of global, networked knowledge communities. From a methodological standpoint, this paradigm calls for participatory, collaborative and predominantly qualitative research approaches capable of capturing the relational and processual dimensions of learning. Methodologies such as action research, design-based research and digital ethnography are particularly consistent with this epistemological orientation.

Nevertheless, collective intelligence remains largely centred on social processes involving human groups. Derrick de Kerckhove extends this perspective by foregrounding the role of technology and introducing the concept of connective intelligence (de Kerckhove, 1997). According to this view, the network is not merely a

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channel for communication among individuals, but a cognitive environment that reshapes the structure of thought and the very conditions under which knowledge is produced. Connectivity encompasses not only interactions among human subjects, but also the mediation of technical artefacts and algorithms that actively influence the organization, retrieval and interpretation of information.

For de Kerckhove, the Internet-connected screen constitutes a new "technology of the intellect", comparable in historical significance to the alphabet or the printing press. It does not simply transmit meanings, but actively "frames" the mind, redefining relationships between perception, memory and action (de Kerckhove, 1997). Knowledge thus becomes a distributed ecosystem composed of cognitive practices, informational networks and technological devices. Within such an environment, epistemic responsibility is extended: individuals are required to develop competences in information management, critical evaluation and ethical reflection.

Connective intelligence gives rise to emergent cognitive processes that transcend the capacities of individual agents. As a dynamic and non-linear system, the network produces forms of collective learning that cannot be inferred from its constituent elements. Knowledge is no longer conceived as a static object, but as a continuous process of renegotiation mediated by discursive practices, cultural contexts and technological infrastructures.

Granieri's analysis of digital society further emphasizes how the widespread adoption of networked technologies is transforming not only modes of communication, but also systems of values, identities and social relations, thereby shaping a new epistemic context in which collective intelligence is constantly activated and renegotiated (Granieri, 2006).

Within this perspective, connective intelligence does not aim at homogenization; rather, it enhances the connections among subjects who preserve their identities while functioning as nodes within a distributed cognitive network (de Kerckhove, 1997). Drawing on McLuhan's legacy and the media ecology tradition, this approach interprets digital technologies as environments that reconfigure cognitive structures, orienting perception, memory and the interpretation of experience.

The Internet-connected screen produces a cognitive transformation comparable to that introduced by alphabetic writing: whereas writing promoted linear and sequential modes of reasoning, networked environments immerse individuals in continuous flows of information, blurring the boundaries between subject and environment, observer and spectacle. The intelligence that emerges is constructed through dynamic, temporary and situated connections. For educational research, this entails the need to investigate not only learning content, but also the cognitive and relational architectures that enable learning, employing methodological tools capable of analysing interaction networks, technological mediation processes and identity construction in digital contexts.

3. Generative artificial intelligence: support or substitute?

Artificial intelligence is among the most widely used - and frequently misunderstood - concepts in contemporary discourse. In educational settings, it is sometimes portrayed as an autonomous entity capable of replacing human thinking. A more precise definition, such as that proposed by UNESCO (2022), describes AI systems as technologies capable of processing data and information in ways that resemble intelligent behaviour, including learning, prediction and control. This definition highlights

that AI is fundamentally an epistemic artefact, constructed through human-designed models, datasets and decision-making processes.

Generative artificial intelligence, in particular, is designed to produce textual, visual and auditory content by identifying statistical regularities within vast training datasets. However, such systems do not "understand" content in a human sense (Russell & Norvig, 2021). This distinction carries significant implications for educational research. AI can facilitate access to information, support advanced data analysis, suggest personalized learning trajectories and identify patterns in educational data that might elude human observation. Yet it cannot replace deep understanding, meaning-making, value negotiation or the contextualization of information within coherent and critically grounded narratives (Floridi, 2016). The knowledge produced by AI systems remains probabilistic, correlation-based and non-conceptual.

The distinction between support and substitution is therefore crucial. When students employ AI tools to address complex tasks, they must be guided to critically interrogate the outputs, verify sources, contextualize results and compare alternative interpretations. Under these conditions, AI functions as a cognitive support rather than as a delegation of thinking. It can amplify human intellectual capacities, but it cannot assume the role of an autonomous epistemic agent.

Bernard Stiegler's notion of technology as a pharmakon - simultaneously remedy and poison - offers a useful interpretive lens (Stiegler, 2010). In educational contexts, AI can enhance learning, improve the personalization of educational pathways and expand access to knowledge. At the same time, if not mediated by critical and reflective practices, it risks fostering dependency, superficial engagement and an illusion of understanding. Pedagogical mediation thus remains indispensable: technology must function as a tool for thought, not as its substitute.

A further risk concerns the illusion of simplicity. The immediate availability of automated responses may lead learners and educators alike to assume understanding where only superficial synthesis has occurred. Learning, as emphasized by major pedagogical traditions, requires time, iterative reflection, critical dialogue and the construction of meaning. Consequently, the integration of AI into educational contexts must be accompanied by teaching practices that foreground collaborative inquiry, critical discussion and problem-solving.

In educational settings, AI is increasingly employed to personalize learning, support learning analytics, facilitate assessment and generate instructional content. These applications, however, raise substantial epistemological and ethical questions. AI systems are not neutral: they embody assumptions, priorities and biases derived from data selection and design contexts. Educational research must therefore integrate pedagogical, technological and ethical competences, developing methodological frameworks capable of critically interpreting algorithmic outputs and assessing their impact on educational processes.

4. Data ethics and responsibility in information storage

The availability of vast quantities of digital data, combined with the capacity of algorithms to process complex datasets, raises ethical issues of paramount importance. In educational research, data storage - including assessment results, learning activities, interactions on digital platforms and access logs - has become a central concern. Data are not neutral artefacts; they encode aspects of identity, preferences,

behaviours and social relations, and their management entails ethical considerations related to privacy, transparency, equity and justice (Floridi, 2016; Verma, 2019).

An often-overlooked issue concerns data governance in educational research and digital learning environments. Every online interaction generates data that can be stored, analyzed and repurposed, giving rise to significant ethical and methodological responsibilities.

Data ethics in education can be articulated along three primary dimensions. The first concerns privacy and security, requiring robust measures to protect personal data and minimize the risks of unauthorized access or misuse. The second involves algorithmic transparency, ensuring that students, teachers and researchers are informed about which data are collected, how they are processed and for what purposes they are used. The third relates to educational justice, necessitating critical evaluation of whether data-driven systems reinforce inequalities, perpetuate stereotypes or marginalize vulnerable groups.

These issues are further intensified by the notion of the "digital double", namely the algorithmic representation of individuals constructed through their online traces. Each digital action contributes to profiles that can be analyzed, aggregated and predicted. While such data can offer valuable insights into learning processes and interaction dynamics, they also raise fundamental questions regarding data ownership, control and purpose.

Educational research must therefore promote responsible data governance practices that balance the scientific use of data with the protection of individual rights. This requires not only technical expertise, but also pedagogical and ethical competences capable of integrating regulatory frameworks with a deep sensitivity to the human dimensions of knowledge production.

5. Methodological implications for educational research

The paradigms of collective intelligence, connective intelligence and artificial intelligence necessitate a profound reconfiguration of educational research methodologies (Barab & Squire, 2004; Kemmis et al., 2014; Pink et al., 2016). The mere adoption of technological tools does not in itself guarantee epistemic progress. Rather, educational research must develop integrated methodological approaches capable of combining qualitative, quantitative and computational methods in a coherent and critically informed manner. This methodological reorientation is closely linked to pedagogical concerns, particularly the need for inclusive and participatory approaches in digital learning environments, as highlighted in recent reflections on teacher education and online pedagogical contexts (Bocci et al., 2022).

First, research must be grounded in epistemic reflexivity. Research tools should not be regarded as neutral instruments for observing reality, but as active constructors of knowledge objects that shape the phenomena under investigation. Consequently, the role of the researcher shifts from that of an external observer to that of a critically engaged participant, aware of the technological mediations involved and their epistemic consequences.

Second, methodological frameworks must embrace multi-perspectivity. Understanding educational phenomena requires integrating data from multiple sources, including participants' lived experiences and culturally situated practices. This calls for hybrid methodologies that combine qualitative and quantitative analysis, narrative inquiry and computational modelling.

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Finally, contemporary educational research must prioritise participatory engagement, valuing the contributions of teachers, students, families and communities. By transforming research into a shared and dialogical process, it becomes possible to harness the full potential of collective intelligence, generating knowledge not as a collection of isolated findings, but as a dynamic weaving of shared meanings.

6. Critical education in the age of AI: perspectives and practices

If digital technologies reshape modes of learning, education must cultivate competences that extend beyond instrumental use. AI can function as a powerful ally when embedded within a broader educational vision that foregrounds critical thinking, argumentative capacity and communicative competence.

A critical approach to AI in education entails teaching students to formulate meaningful questions, interpret AI-generated responses and critically examine underlying assumptions. Educational practices should explicitly address both the affordances and limitations of intelligent systems, for instance through activities centred on fact-checking, source evaluation and comparative analysis of outputs.

Education must prioritise depth of understanding. Knowing what is correct is insufficient without understanding why an answer is coherent, which epistemic assumptions underpin it and what social and cultural implications it carries. Such forms of knowledge organisation cannot be automated; they require pedagogical mediation, intersubjective dialogue and sustained critical reflection.

Equally essential is education for digital citizenship. Learners must develop awareness of their digital rights, learn to protect their privacy, acquire competences in data interpretation and actively participate in online learning communities. These skills are indispensable for informed, democratic participation in contemporary societies..

7. Conclusion: towards a conscious, critical and human-centred educational research

Collective intelligence, connective intelligence and artificial intelligence represent powerful conceptual and technological resources. However, their potential can be fully realised only when they are embedded within a critical, reflective and human-centred pedagogical framework (McLuhan, 1964; de Kerckhove, 1997; Lévy, 1994; Granieri, 2006). Educational research must resist the temptation to passively follow technological trends and instead critically interrogate the epistemic and ethical assumptions that underpin them, designing methodologies capable of integrating technological innovation with depth of understanding and ethical responsibility.

As McLuhan and de Kerckhove remind us, technology is not an inevitable destiny, but a space of possibilities that can be interpreted, negotiated and transformed through culture, critical reflection and collective engagement. The educational challenge lies in ensuring that technology serves as an instrument of cognitive and social emancipation rather than as a mechanism for the automatic delegation of thought. Human intelligence - with its capacities for judgement, creativity and critique - remains the irreplaceable foundation of meaningful knowledge.

In this perspective, future education must be not only digital, but also critical, ethical and oriented towards meaning-making. It should prepare individuals capable of navigating complexity, interpreting data, questioning algorithms and contributing

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responsibly to the shared production of knowledge. Under these conditions, technology ceases to function as an ambiguous phàrmakon and becomes an ally in the construction of a genuinely human, collective and connected form of knowledge.

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