EMBODIED INCLUSION IN EMOTIONALLY AWARE HYBRID LEARNING ENVIRONMENTS: A CASE STUDY ON VISUAL IMPAIRMENT

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ABSTRACT

This proposal explores the design of hybrid, emotionally aware learning environments through a case study in an Italian upper-secondary classroom involving a student with a visual impairment. Grounded in embodied cognition and sociocultural theory, the study investigates how interaction, space, and mediational tools co-construct accessibility and participation. Data were collected using multiple qualitative methods and analyzed through reflexive thematic analysis. Findings highlight the emergence of a "distributed didactic body" in which relational, spatial, and technological elements dynamically shape inclusion. Within such hybrid ecologies, technology functions not merely as a compensatory tool but as a relational interface that can either enhance or hinder affective attunement. The study argues for the intentional design of learning environments that integrate sensory, digital, and social dimensions to support both cognitive access and a sense of emotional belonging.

KEYWORDS

Visual impairment; embodied inclusion; hybrid learning environments.

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1. Introduction

In recent years, the growing adoption of digital technologies and artificial intelligence in educational settings has profoundly reshaped contemporary learning ecologies (Barron, 2006; Holmes *et al.*, 2019), transforming not only the tools of didactic mediation but also the relational, embodied, and emotional configurations through which participation and belonging are constructed. Contemporary educational environments increasingly take the form of hybrid learning spaces in which physical and digital dimensions, technological mediations, communicative practices, and affective processes continuously interact (Goodyear & Carvalho, 2014; Raes *et al.*, 2020). From an ecological and systemic perspective, educational experience may be understood as a system of interconnected relational processes in which meaning emerges through continuous interaction among individuals, environments, and communicative practices (Bateson, 1972). In this context, the "Fourth Revolution" is not merely a technical transformation but also implies a redefinition of how individuals construct meaning, engage in relationships, and experience their presence within social and educational contexts (Floridi, 2014).

Within these hybrid ecologies, the quality of educational processes cannot be reduced to the mere availability of technological tools or the functional dimension of content access. Rather, there is a growing need to investigate how technologies, bodies, emotions, and interactions jointly contribute to the construction of genuinely inclusive and participatory environments (Goodyear & Carvalho, 2014; Zembylas, 2007). From this perspective, the notion of emotionally aware learning environments becomes relevant not primarily because of the possibility of monitoring or simulating emotional states through algorithmic systems (Picard, 1997), but because of the capacity of educational contexts to sustain authentic forms of relational attunement, mutual recognition, and affective belonging (Stern, 1985; Zembylas, 2007). This interpretation moves beyond computational conceptions of emotional awareness, reframing it as a pedagogical and relational

property that emerges through embodied interaction, shared meaning-making, and situated participation rather than through algorithmic emotion detection.

This perspective implies the progressive overcoming of traditional dichotomies between mind and body, cognition and emotion, and individual and environment, which remain implicit in parts of contemporary educational discourse. Embodied cognition approaches have highlighted that the body is not merely a biological support for learning but a constitutive dimension of cognitive, perceptual, and relational processes (Gallagher, 2005). At the same time, the sociocultural perspective has shown that higher psychological functions develop through social and cultural mediation situated within interactive practices (Vygotsky, 1978). From this standpoint, learning cannot be interpreted as an exclusively individual or mental process but as a situated and relational experience that takes shape through interaction with others, tools, and contexts (Sibilio, 2020). Similarly, studies of situated interaction have demonstrated that human action is constructed through the simultaneous use of multiple semiotic, embodied, spatial, and material resources (Goodwin, 2000). Educational practices may therefore be understood as distributed processes in which postures, gestures, spatial orientations, language, tools, and interactional dynamics jointly contribute to the production of educational experience. Within the pedagogical field, these reflections are further developed through approaches that emphasize the vicarious function of educational mediation, according to which teaching and learning processes emerge through complex systems of embodied interaction in which corporeality, environment, and relational dynamics jointly contribute to the construction of educational experience (Sibilio, 2017, 2020). Building on these perspectives, the present study adopts the notion of the *distributed didactic body* as an interpretive lens to examine how educational agency is distributed across teachers, peers, technologies, spatial arrangements, and communicative practices in the construction of inclusive participation.

These perspectives are especially significant in inclusive educational contexts. School inclusion cannot be understood as the outcome of isolated technical adaptations or compensatory interventions, but rather as an ecological and relational process that encompasses the entire configuration of classroom life. Participation develops within ecological systems shaped by reciprocal interactions among individuals, environments, and social practices (Bronfenbrenner, 1979). In this sense, inclusive educational practices require the construction of "possible worlds" that sustain participation, agency, and meaningful forms of relational belonging within everyday school experience (Aiello, 2017). Inclusion, therefore, entails transforming school cultures, practices, and organizational structures to support learning and participation for all students (Canevaro, 2006; Booth & Ainscow, 2011). Accessibility, consequently, does not merely coincide with the availability of tools or supports, but concerns the conditions that enable students to orient themselves, participate in interactions, share meanings, and experience recognition within the educational community.

Such dynamics are particularly evident in educational contexts involving students with visual impairments, where accessibility, spatial orientation, communicative mediation, and relational participation are deeply intertwined. Research on the linguistic and social development of blind children shows that meaning-making and social participation depend strongly on the quality of shared interactions and communicative practices (Pérez-Pereira & Conti-Ramsden, 1999). In these settings, the quality of the school experience depends not only on the availability of assistive technologies or compensatory devices but also on the educational environment's ability to create interactional configurations that make classroom dynamics intelligible, support situated orientation and foster embodied participation. Within this framework, the affective dimension assumes a central role. Emotional attunement is fundamental to the construction of the self and to relationships with others (Stern, 1985). Applied to contemporary educational contexts, this perspective allows learning environments to be interpreted not merely as spaces of

cognitive transmission but as relational ecologies in which the quality of embodied, communicative, and technological mediations contributes to the construction of belonging and participation.

Building on these premises, the present study aims to explore the relationship among embodied inclusion, affective mediation, and hybrid learning environments through a qualitative case study conducted in an Italian upper-secondary school involving a student with a visual impairment. The study investigates how interactions, educational practices, spatial configurations, and technological mediations contribute to the construction of accessibility, participation, and affective attunement in everyday school life.

More specifically, the study addresses the following research questions:

1. How do embodied interactions and relational mediations contribute to the construction of accessibility and participation in hybrid learning environments for a student with a visual impairment?
2. How do technological, spatial, and affective dimensions interact in the construction of inclusive practices that support affective attunement within the classroom?

2. Methodology

The present study is grounded in a qualitative, interpretive perspective that explores how accessibility, participation, and relational mediation take shape in everyday school life. Consistent with this epistemological framework, the research was conducted as a qualitative case study to gain an in-depth understanding of the interactive, embodied, and situated configurations that characterize the educational experience of a student with visual impairment. Case study research enables the analysis of complex phenomena within their real-life context while preserving their processual and relational nature (Yin, 2018).

The study was conducted between March and November 2025 in an Italian upper secondary school and involved a classroom with a student with a visual impairment. The investigation focused on observing ordinary teaching practices and everyday participation dynamics, with particular attention to how interactions, spatial organization, communicative mediations, and technological tools contributed to the construction of inclusive educational experiences.

Data collection employed methodological triangulation, integrating multiple qualitative tools to capture the multidimensionality of the phenomenon under investigation (Patton, 2015). In particular, the study included direct, non-participant observations of classroom activities, supported by an observational grid focused on interactional configurations and mediation practices. At the same time, a reflective field diary documented emerging dynamics, while semi-structured interviews, focus groups, and questionnaires were administered to teachers and classmates, providing further insights into perceptions of inclusion, everyday participation practices, and the use of technological and relational mediations in the classroom.

Observations were conducted during the second semester of the 2024/2025 school year across subjects and at different times of the school day to capture variability in interactional practices and didactic configurations. Observational attention focused on the student's modes of participation, processes of orientation and situated accessibility, embodied and verbal mediations, peer collaborative dynamics, and the use of digital and assistive tools. Attention was also devoted to classroom spatial configurations and to episodes that could facilitate or hinder participation in educational activities.

The semi-structured interviews were designed using a flexible approach to foster the emergence of participants' interpretations and meanings of educational experiences (Patton, 2015). Similarly, focus groups with classmates enabled exploration of collaborative practices, relational dynamics, and the ways in which shared forms of participation and mediation were constructed within everyday

school experiences. Finally, questionnaires administered to teachers and students collected data on perceptions of inclusive dynamics, classroom relationships, and the use of technological and communicative mediations in participation processes.

Data analysis was developed through a recursive process of coding and interpretation, inspired by reflexive thematic analysis (Braun & Clarke, 2006). This approach enabled the identification of recurring patterns and emerging thematic nuclei by integrating the various empirical materials collected. The analytical process involved several stages: familiarization with the data, initial coding, construction of interpretive categories, identification of cross-cutting themes, and progressive theoretical reinterpretation of the findings.

Consistent with the interpretative perspective adopted, the study does not aim at statistical generalization but rather at an in-depth understanding of the situated processes through which inclusion takes shape within everyday educational practices. The credibility of the analysis was supported by source triangulation, reflexivity throughout the interpretative process, and constant attention to coherence among the theoretical framework, empirical data and analytical construction (Lincoln & Guba, 1985). Considering this methodological perspective, the analysis focused not only on the presence of formally inclusive practices or tools but, above all, on how bodies, technologies, spaces, and relationships jointly contribute to the construction of accessible, participatory, and affectively meaningful educational environments.

Table 1*:* Summary of data collection tools

Tool	Purpose	Participants
Non-participant observations	Analysis of embodied interactions and inclusive practices	Classroom
Observational grid	Identification of interactional and participatory configurations	Classroom
Reflective field diary	Documentation of emerging dynamics and reflexive notes	Researcher
Semi-structured interview	In-depth exploration of lived experience	Student with visual impairment
Focus groups	Exploration of relational and collaborative dynamics	Classmates
Questionnaires	Perceptions of inclusive practices and technological mediations	Teachers and classmates

3. Results

Data analysis was developed through a multilayered triangulation process that integrated observational data (reflective field diary and observational grid), questionnaires administered to teachers and classmates, focus groups, and an interview with the student with visual impairment. Integrating these sources enabled the reconstruction of the embodied, relational, and technological configurations that shape the observed educational experience, highlighting how accessibility, participation, and affective attunement are situationally constructed within hybrid learning environments.

Thematic analysis identified three main interpretive themes: (1) accessibility as a relational and embodied process; (2) distributed relational mediation within everyday classroom practices; and (3) the role of technological mediation in the construction of participation and affective attunement.

Table 2: Main interpretative themes emerging from the analysis

Theme	Interpretative Categories	Main Data Sources
Accessibility as relational and embodied process	Situated accessibility; verbalization; shared orientation; embodied interaction	Observations, student interview, teacher questionnaires
Distributed relational mediation	Peer mediation; interactional regulation; shared participation	Observations, focus groups, questionnaires
Hybrid mediation and affective attunement	Technological mediation; digital accessibility; participation; affective belonging	Observations, interviews, questionnaires

3.1 Accessibility as a relational and embodied process

One of the most significant findings concerns the relational and situated nature of educational accessibility. The data show that the student's participation did not depend solely on the availability of adapted materials or compensatory tools, but rather on the overall quality of the communicative and embodied configurations through which educational activities were enacted.

The observational diary frequently reports episodes in which implicit reliance on the visual channel led to participatory misalignment. During frontal teaching activities, deictic expressions or non-verbalized spatial references tended to make the activity's dynamics less intelligible:

> *"The student asks what the teacher is referring to. A classmate intervenes by verbally describing the content written on the board." (Observational diary, February 2025)*

These observations are consistent with what emerged from the teachers' questionnaires, in which the need to make the lesson's communicative structure more explicit was frequently emphasized:

> *“This experience led me to verbalize passages that I would normally leave implicit.” (Teacher questionnaire, Section 2)*

> *“I realized how heavily teaching depends on the visual channel.” (Teacher questionnaire, Section 3)*

The analysis, therefore, suggests that accessibility does not emerge as an intrinsic property of materials or activities but rather as a process continuously constructed through practices of verbalization, shared orientation, and the regulation of interaction in context.

At the same time, data show that the body plays a central role in learning and participation. Observations on the embodied dimension highlight the importance of tactile exploration, bodily orientation, and attentive postures in shaping the school experience:

> *“During the tactile activity, the student slowly explores the material with both hands while following the explanation verbally.” (Observational diary, March 2025)*

Teachers also recognized significant cognitive and educational value in the embodied dimension:

> *“The body becomes an integral part of understanding, not merely a support for the activity.” (Teacher Questionnaire, Section 4)*

Overall, the findings highlight that accessibility and participation arise from embodied configurations of interaction, in which verbalization, corporeality, and spatial organization jointly contribute to the construction of educational experience.

Table 3: Evidence related to the first theme emerging from the analysis: Accessibility as a relational and embodied process.

Empirical Evidence	Code	Interpretative Category
"The student asks what the teacher is referring to."	compensatory verbalization	situated accessibility
Need to make implicit references explicit	verbal mediation	intelligibility of interaction
Integrated use of verbalization and tactile supports	embodied mediation	shared orientation

3.2 Distributed relational mediation

The second interpretive theme emerging from the analysis concerns the distributed nature of the relational mediations that support the student's participation in the classroom. Observations show that understanding, orientation, and accessibility were often constructed through collaborative processes involving teachers, classmates, tools, and shared communicative practices.

In several observed episodes, classmates spontaneously intervened by articulating implicit information or describing visual elements necessary for understanding the activity:

> *"A classmate verbally describes the slide's content while the student takes notes in Braille." (Observational diary, April 2025)*

During the focus groups, some students described these practices as increasingly integrated into everyday classroom routines:

> *"Sometimes we explained aloud what the teacher was demonstrating on the board." (Focus group, Group 2)*

> *"Over time, it became natural to speak more." (Focus group, Group 4)*

Observations further highlighted that the most participatory configurations coincided with situations in which relational mediation was embedded in everyday classroom practices rather than confined to formally separated or individualized moments.

At the same time, the findings show that the quality of participation depends not only on cognitive access to content but also on the construction of forms of communicative reciprocity and shared presence. In several observed situations, the student appeared more actively involved in contexts characterized by dialogic interactions, shared verbalizations, and a greater circulation of communication within the classroom group.

Taken together, these configurations outline a distributed system of embodied and relational mediations through which participation is continuously constructed and regulated within the classroom ecology.

Table 4: Evidence related to the second theme emerging from the analysis: Distributed relational mediation.

Empirical Evidence	Code	Interpretative Category
Spontaneous verbalizations by classmates	peer mediation	shared participation
Collaborative description of visual content	interactional regulation	situated orientation
Spontaneous integration of mediation practices into classroom routines	distributed mediation	relational ecology

3.3 Hybrid mediation and affective attunement

The third interpretive theme emerging from the analysis concerns the role of technologies within the observed educational ecologies. The findings show that digital tools and assistive technologies do not merely serve as instrumental supports for accessing content but actively shape the embodied, relational, and participatory dynamics of the classroom (Clark, 2008; Kaptelinin & Nardi, 2009; Di Gennaro & Amadoro, 2024). From this perspective, technological mediation emerges as an

integral component of the embodied experience of learning, redefining temporalities, interactional modes, and possibilities for participation (Gallagher, 2005; Sibilio, 2020; Sibilio *et al.,* 2023).

Throughout the observations, there was consistent use of speech synthesis, Braille, accessible digital materials, and audio supports. These tools enabled the student to access content with greater autonomy and more consistent participation:

> *"The student independently adjusts the speed of the speech synthesis to follow the reading of the text." (Observational diary, March 2025)*
>
> *"During the study activity, she uses the Braille display to independently check the content of the digital material." (Observational diary, April 2025)*

Teachers also attributed a significant role to technology in supporting autonomy:

> *"Digital tools allow the student to work more independently and manage her own pace." (Teacher questionnaire, Section 3)*
>
> *"Technology enables her to access information without relying continuously on adult mediation." (Teacher questionnaire, Section 4)*

However, the analysis also highlights that the effectiveness of technological mediation does not depend exclusively on the technical features of the tools themselves, but on how they are embedded within the classroom's relational and communicative configurations. Observations show that technologies become more inclusive when they operate in continuity with shared verbalizations, collaborative practices, and situated, embodied mediations.

During an audiovisual analysis activity, for example, the student's participation was supported not only by audio assistance but also by classmates' spontaneous verbalizations:

> *“During the video viewing, some classmates spontaneously comment on the scenes and describe relevant visual elements while the student follows the content with audio support.” (Observational diary, April 2025)*

In another observed situation during a laboratory activity, classmates spontaneously adapted their communicative practices to the technological mediation used by the student:

> *“Classmates wait for the student to finish the reading via speech synthesis before continuing the activity.” (Observational diary, May 2025)*

These configurations suggest that inclusive participation is more effective when technology is integrated into shared practices of reciprocal regulation (Vygotsky, 1978; Wenger, 1998). In such situations, the digital tool does not replace the relational dimension of the educational experience but becomes part of a hybrid mediation in which the body, technology, and social interaction operate in concert (Hollan *et al.*, 2000; Gallagher, 2005; Sibilio, 2020).

At the same time, the findings reveal the ambivalent role of assistive technologies in the school experience. On the one hand, digital tools foster autonomy and accessibility; on the other hand, they may create configurations of parallel participation in which the student’s experience unfolds along temporal and relational trajectories that differ from those of the rest of the class. This dynamic is particularly evident in situations marked by a strong individualization of technological mediation:

> *“During the viewing of the video material, the student follows the content through headphones and receives separate audio support from the rest of the class.” (Observational diary, April 2025)*

> *“While the class collectively completes the activity, the student continues with individual listening to the digital material.” (Observational diary, May 2025)*

The perception of this misalignment also emerged during the student interview:

> *"Sometimes I can follow everything, but I still feel somewhat disconnected from the others." (Student interview)*

> *"With some tools, I can work better, but sometimes it feels like I am in a different time than the rest of the class." (Student interview)*

The analysis, therefore, suggests that cognitive accessibility and relational participation do not necessarily coincide (Booth & Ainscow, 2011; Florian & Black-Hawkins, 2011). Assistive technologies may guarantee access to content without necessarily producing fully shared forms of presence and belonging. From this perspective, the inclusive potential of hybrid learning environments depends on the ability to integrate technological mediations into embodied and relational configurations that sustain reciprocal interactions and shared participation (Gallagher, 2005; Goodyear & Carvalho, 2014; Sibilio, 2020; Cottini, 2017)

Another relevant element emerging from the findings concerns the relationship between technological mediation and the temporal regulation of educational activities. In several observed episodes, the autonomous management of digital tools enabled the student to personalize the timing and modalities of accessing information; at the same time, however, this individual regulation occasionally produced asynchronies with the classroom's collective rhythms.

> *"The student continues listening to the audio material even though the class has already moved on to the next activity." (Observational diary, May 2025)*

> *"The teacher temporarily interrupts the explanation to allow the student to complete the consultation of the digital material." (Observational diary, May 2025)*

In these situations, the possibility of maintaining continuity of participation depended on the presence of relational practices that realigned individual experience with the classroom's collective dynamics. Observations show that the

most inclusive configurations coincided with situations in which shared verbalizations, spontaneous adjustments to teaching rhythms, and collaborative practices helped sustain synchronized, reciprocally regulated participation.

Focus groups also revealed a perception of a transformation in relational practices mediated by technology:

> *"Over time, we learned to wait longer and explain things more clearly." (Focus group, Group 3)*
>
> *"When digital materials are used, you have to be more careful not to move ahead too quickly." (Focus group, Group 1)*

Within this framework, the affective dimension assumes a central role. The findings suggest that the quality of the inclusive experience depends not only on access to content but also on recognition, reciprocity, and belonging in everyday interactions. Affective attunement, therefore, emerges not as an individual or exclusively emotional condition but as a situated and distributed process, constructed through the dynamic integration of embodied, relational, and technological mediations. The observed configurations show that the most participatory environments do not necessarily coincide with the most technologically advanced ones, but rather with those that integrate digital tools, embodied mediations, and relational regulation within shared practices of participation. From this perspective, hybrid learning environments may be understood as relational ecologies in which the inclusive potential of technologies depends on their capacity to sustain shared forms of presence, synchronization, and belonging.

Table 5: Evidence related to the third theme emerging from the analysis: Hybrid mediation and affective attunement.

Thematic Core	Main Empirical Evidence	Interpretation
Technologies as devices of agency	Autonomous use of speech synthesis, Braille displays, and accessible digital materials	Technologies foster autonomy and continuity of participation, supporting access to content
Hybrid mediation and shared participation	Collaborative verbalizations, shared description of visual content, and reciprocal regulation of timing	Inclusion emerges when digital tools, the body, and social interaction operate within integrated configurations
Parallel participation and asynchrony	Individualized use of content, separate use of audio and digital supports	Cognitive accessibility and relational participation do not automatically coincide
Temporal regulation of interaction	Reciprocal waiting, spontaneous adjustment of teaching rhythms, collaborative synchronization	Continuity of participation depends on the classroom's ability to realign individual and collective temporalities
Affective attunement in hybrid environments	Reciprocal support practices, shared verbalizations, and attention to participatory rhythms	Affective attunement emerges as a distributed process constructed through embodied, relational, and technological mediations

4. Discussion

The findings from the analysis make it possible to interpret school inclusion not as the automatic outcome of the availability of compensatory tools or assistive technologies, but rather as a relational, embodied, and situated process that takes shape within the classroom's interactive ecologies (Booth & Ainscow, 2011; Florian & Black-Hawkins, 2011; Gallagher, 2005; Sibilio, 2020). From this perspective, accessibility does not coincide exclusively with the ability to access content cognitively, but concerns the ways in which bodies, technologies, languages, and communicative practices jointly contribute to the construction of educational participation. These findings are consistent with approaches to embodied cognition, according to which cognition, perception, and learning emerge through the dynamic interaction among the body, the environment, and situated action (Gallagher, 2005).

Observations on the implicit use of the visual channel further show that many elements of ordinary classroom communication often remain epistemologically invisible. Deictic expressions, implicit spatial references, and nonverbalized mediations reveal that the school environment is often organized around shared perceptual assumptions that remain tacit until the presence of a student with visual impairment exposes their exclusionary character. In this sense, the findings confirm studies on situated interaction, which hold that meaning is constructed through the simultaneous orchestration of embodied, spatial, and semiotic resources (Goodwin, 2000).

The findings also highlight that the quality of the inclusive experience depends significantly on distributed practices of relational mediation. Classmates' spontaneous verbalizations, collaborative regulation of interactional timing, and the integration of mediation practices into everyday routines demonstrate that participation is constructed through collective processes of embodied and communicative coordination. These configurations align with perspectives that interpret learning and participation as processes emerging from shared practices of mutual engagement within social communities (Wenger, 1998). They also align with sociocultural perspectives that interpret learning as a mediated and relational process (Vygotsky, 1978), while suggesting the need to extend this interpretation to include the embodied and technological dimensions of contemporary educational practices. In this sense, the concept of a "distributed didactic body" allows educational action to be interpreted not as a process confined to the teacher's role but as an ecological configuration distributed across subjects, tools, languages, spatial arrangements, and interactional practices. This interpretation is consistent with reflections on the vicarious function in educational mediation, according to which teaching and learning emerge through complex systems of embodied and distributed interaction (Sibilio, 2020; Sibilio *et al.*, 2023).

The study's central contribution concerns the role of technologies in hybrid learning environments. The findings suggest that assistive technologies cannot be viewed as neutral tools or merely functional devices for accessing content, but rather as mediational devices capable of redefining the temporal, relational, and affective configurations of educational experience (Vygotsky, 1978; Wertsch, 1998; Clark, 2008; Sibilio, 2020). These findings align with perspectives on extended and embodied cognition, according to which cognitive processes emerge through the dynamic integration of body, tools, and environment (Clark, 2008). They are also consistent with perspectives that emphasize the role of tiflodidactic and digital educational mediation in supporting accessible and participatory learning environments for students with visual impairment (Di Gennaro & Amadoro, 2024). In particular, the analysis highlights the deeply ambivalent character of technological mediation. On the one hand, tools such as speech synthesis, Braille displays, and accessible digital materials foster autonomy, agency, and continuity of participation, allowing the student to regulate her own timing and modes of access to information. On the other hand, observations indicate that individualized uses of technology may generate parallel and asynchronous forms of participation relative to the collective dynamics of the classroom. Within these configurations, cognitive accessibility does not necessarily coincide with fully shared forms of relational and affective participation.

These findings appear particularly relevant to the contemporary debate about emotionally aware learning environments. The data suggest that the inclusivity of hybrid environments does not depend solely on advanced technologies or the algorithmic capacity to detect emotional states, but rather on the ability to integrate digital tools, embodied mediations, and relational practices into configurations that sustain mutual recognition, participatory synchronization, and belonging. From this perspective, hybrid environments may be understood as relational ecologies in which technology contributes to the construction of educational experience only when embedded within shared participatory practices (Floridi, 2014).

Within this framework, the affective dimension serves a structural function. The findings show that the quality of participation depends not only on access to content but also on the possibility of experiencing relational continuity, reciprocity, and shared presence in everyday interactions. Affective attunement, therefore, emerges not as an individual or exclusively emotional condition but as a distributed process, constructed through the dynamic integration of embodied, communicative, and technological mediations. This interpretation aligns with Stern's (1985) conception of affective attunement as a relational process of intersubjective coordination through which individuals dynamically regulate attention, intentions, rhythms, and reciprocal presence within interaction, thereby fostering experiences of mutual recognition, participation, and belonging.

Overall, the findings suggest the need to move beyond a technocentric conception of digital inclusion (Floridi, 2014; Goodyear & Carvalho, 2014). Technologies are not inherently inclusive; they are inclusive only to the extent they are integrated into educational ecologies that sustain embodied accessibility, communicative reciprocity, and shared participation (Booth & Ainscow, 2011; Florian & Black-Hawkins, 2011; Sibilio, 2020). In this sense, hybrid learning environments may be understood not as simple integrations of physical presence and digital tools, but as complex relational configurations in which body, technology, and affective experience jointly contribute to an inclusive educational experience (Gallagher, 2005; Zembylas, 2007; Goodyear & Carvalho, 2014).

5. Conclusions

The present study examined the relationship among embodied inclusion, technological mediation, and affective attunement in a hybrid learning environment involving a student with a visual impairment. Using a qualitative, interpretive approach, the research showed that accessibility and participation cannot be understood solely in terms of technical adaptation or the availability of

compensatory tools. Instead, they should be understood as relational, embodied, and situated processes that emerge from the dynamic interaction among subjects, technologies, communicative practices, and the organization of the educational environment.

The findings show that assistive technologies play a significant role in supporting autonomy and access to content. However, consistent with reflections on hybrid learning ecologies (Floridi, 2014), their inclusive potential appears to depend closely on the relational and embodied configurations in which they are embedded. In particular, the most inclusive configurations coincide with situations in which technological mediations, shared verbalizations, relational regulation, and embodied practices operate in an integrated manner, sustaining shared forms of orientation, participation, and belonging. From this perspective, inclusion emerges as a distributed ecological configuration rather than as the outcome of isolated, individualized, or compensatory interventions. Educational participation appears to be sustained by the continuity of embodied and relational mediations that traverse classroom life, confirming the need to interpret contemporary educational environments as hybrid ecologies in which body, technology, and relationships jointly contribute to the construction of school experience. These findings are consistent with perspectives that interpret learning as a situated and mediated process (Vygotsky, 1978; Goodwin, 2000).

The study further suggests that the quality of emotionally aware learning environments does not depend exclusively on advanced technologies or sophisticated digital systems, but rather on the ability of educational contexts to sustain relational coordination, communicative reciprocity, and shared participation. From this perspective, the “emotionally aware” dimension of the environment cannot be reduced to a merely technological or computational capacity, such as the simple ability of digital systems to detect, monitor, or simulate emotional states. On the contrary, the findings show that the affective quality of the

educational experience primarily emerges from the embodied and relational configurations through which students, teachers, and technologies co-construct participation in everyday classroom practices.

This interpretation appears consistent with Stern's (1985) conception of affective attunement, according to which attunement does not simply consist of emotional sharing but rather involves the capacity to coordinate intentions, rhythms, attention, and reciprocal presence within interaction. Attunement is therefore a dynamic process of intersubjective regulation through which individuals construct shared experiences of reciprocity and recognition. Considering the findings, the affective attunement observed within hybrid learning environments does not appear to be directly produced by technology itself but is mediated by the capacity of educational practices to integrate digital tools, shared verbalizations, temporal regulation, and embodied mediations within common participatory configurations. In this sense, technologies become inclusive not merely insofar as they increase access to content, but also insofar as they help sustain shared forms of presence, synchronization, and belonging. The findings, therefore, suggest interpreting emotionally aware learning environments as embodied relational ecologies in which cognitive, embodied, technological, and affective dimensions operate in an integrated way in the construction of educational experience.

From a pedagogical and educational perspective, the findings highlight several implications. First, there is a need to promote teaching practices that make the communicative and spatial structures of educational interaction more explicit through shared verbalizations, multimodal mediations, and attention to the embodied dimension of learning (Gallagher, 2005). Second, the study underscores the importance of integrating assistive technologies into ordinary classroom practices while avoiding configurations that risk generating parallel or individualized forms of participation. Additional implications concern teacher education and the design of hybrid learning environments. The findings suggest the need to develop

pedagogical competencies oriented not only toward the technical use of digital tools but also toward the construction of educational ecologies that integrate embodied, technological, and relational mediations within shared participatory practices (Florian & Black-Hawkins, 2011; Goodyear & Carvalho, 2014; Redecker, 2017; Sibilio, 2020). In this direction, perspectives emphasizing the vicarious function in teaching and learning processes may provide a useful interpretive framework for rethinking inclusive practices within contemporary educational contexts (Sibilio, 2017; Aiello, 2017).

The study inevitably has limitations stemming from the qualitative and situated nature of the case study and the specificity of the observed context. Nevertheless, the investigation's analytical depth enables an articulated interpretation of the dynamics through which inclusion, technology, and participation take shape within everyday school life. Building on these considerations, future research could further explore the role of technological mediations in constructing inclusive participation for students with visual impairments across different hybrid educational configurations. It would be useful to investigate how assistive technologies, collaborative practices, and the temporal organization of teaching influence the embodied dynamics of participation and affective attunement across different school contexts.

A further area for future investigation concerns the potential contribution of artificial intelligence to the development of assistive technologies for visual impairment and to inclusive learning environments (Holmes *et al.*, 2019; UNESCO, 2023). Future studies could explore how AI-based systems may enable dynamic accessibility, content personalization, multimodal description, and real-time communicative support to sustain more fluid and participatory forms of interaction within hybrid learning ecologies (Luckin, 2018; UNESCO, 2023). Finally, it would be valuable to extend the investigation to other educational contexts and profiles of educational needs to better understand how relationships among body, technology,

and participation are configured across contemporary learning environments (Florian & Black-Hawkins, 2011; Goodyear & Carvalho, 2014).

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