FROM EMOTIONAL DATA TO PEDAGOGICAL MEDIATION: HYBRID AND EMOTIONALLY AWARE LEARNING ENVIRONMENTS IN LOWER SECONDARY SCHOOLS

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ABSTRACT
This paper examines the relationship between emotional data, pedagogical mediation and educational relationships in lower secondary schools through emotionally aware learning environments inspired by Affective Computing. Using a mixed-methods design with 110 students, the study found improvements in engagement, well-being and prosocial skills, especially among students with Specific Learning Disorders, highlighting the value of emotionally sensitive technologies for inclusive teaching.

KEYWORDS
Hybrid learning environments; Affective computing; Pedagogical mediation; Social-emotional skills; Educational inclusion.

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1. Introduction

In today's educational contexts, the growing integration of smart technologies is significantly redefining the relationship between learning, emotion and social interaction, opening up pedagogical scenarios that challenge the very meaning of the educational experience (Holmes, 2020; Zawacki-Richter et al., 2019). In particular, the development of Affective Computing—understood as the set of technologies capable of recognising, interpreting and simulating emotional states—introduces the possibility of teaching that pays greater attention to the affective dimension of learning processes (Calvo et al., 2015). Through interactive digital systems, it becomes possible to collect and process information relating to the emotions expressed by students, offering new opportunities for personalisation and support (D'Mello & Graesser, 2015, Luckin, 2018).

However, despite these developments, the literature highlights a persistent tension between the expansion of emotion-detection technologies and their effective pedagogical integration. In particular, a significant gap remains between the availability of affective data and the ability to translate it into meaningful, relationally grounded educational practices (Prinsloo & Slade, 2017, Slade & Prinsloo, 2013). This critical issue raises important questions: what meaning should be attributed to emotional data? To what extent can its measurement translate into a genuine understanding of the student's subjective experience? It is precisely in the transition from 'emotional data' to 'educational relationship' that a crucial tension emerges: the risk is that the educational experience will be progressively reduced to a measurable dimension, in which emotions are treated as indicators to be monitored, losing their dynamic, situated and deeply relational nature (Selwyn, 2019; Williamson & Eynon, 2020). In this sense, the comparison between Affective Computing

and Embodied Cognition highlights a significant theoretical tension. Whilst affective technologies allow us to refocus attention on emotions within educational processes, embodied perspectives emphasise that emotional experience cannot be isolated from the body, the context, and the relationship with others (Barsalou, 2008, Immordino-Yang et al., 2019; Wilson, 2002). This gives rise to the need for pedagogical mediation capable of interpreting the data, transforming it into an opportunity for shared reflection, without reducing it to mere technical information (Järvenoja et al., 2023; Ochoa & Worsley, 2016). These dynamics take on particular significance in lower secondary school, a phase in which students undergo profound changes in terms of identity, emotions and relationships. In this context, school is not merely a place for cognitive learning, but a space for self-construction and the development of social skills (Eccles & Roeser, 2011, Gao et al., 2024). The inclusion of students with Specific Learning Disorders (SLD) makes the importance of the affective dimension even more evident: for these students, who are often exposed to experiences of frustration and vulnerability, the recognition and regulation of emotions are essential conditions for well-being and educational success (Roffey, 2012). In this context, it is necessary to clarify operationally the meaning attributed to the concept of 'emotional data', which is often used ambiguously in the literature. In this paper, emotional data is understood as a multi-level construct, encompassing both information gathered through technological devices (e.g. digital feedback, self-reported expressions, behavioural indicators) and the pedagogical interpretations derived from it within the educational relationship. In particular, a distinction is made between:

- collected emotional data, that is, the set of observable and recordable traces gathered through digital tools or structured methodologies, which provide a partial and situated representation of the student's emotional state;
- interpreted emotional data, understood as the result of a process of pedagogical mediation through which such information is contextualised, discussed and transformed into meaning within the educational relationship.

This distinction helps to avoid reducing emotional experience to mere technical information, emphasising that the educational value of the data lies not in its collection per se, but in its shared and situated interpretation (Biesta, 2020). In light of these considerations, hybrid and emotionally aware learning environments can be interpreted as potentially inclusive frameworks, provided they are designed as relational spaces rather than mere technological tools (Holmes & Tuomi, 2022). From this perspective, technology takes on the role of mediator: no longer a tool of control or mere data collection, but a resource capable of making often implicit emotional dynamics visible, supporting processes of awareness, metacognition and self-regulation (Ifenthaler & Yau, 2020, Panadero et al., 2018). Within this framework, citizenship education emerges as a prime area for experimentation. Understood as the development of collaborative, ethical and relational skills, it is founded on the ability to recognise others, cooperate and manage conflicts (Johnson & Johnson, 2018). Technologies based on Affective Computing, if integrated critically, can help support these processes, offering opportunities for reflection on individual and collective emotional experiences, without replacing the educational relationship but making it more conscious. In light of this theoretical framework, this paper aims to bridge the gap between the collection of

emotional data and its pedagogical interpretation, offering not only the analysis of a situated empirical case but also design criteria for the construction of hybrid and emotionally aware learning environments, in line with the transformations of educational contexts in the so-called Fourth Industrial Revolution.

2. Aims of the research

In light of the theoretical framework outlined above, this study aims to systematically investigate the relationship between emotional data and the educational relationship within learning environments mediated by technologies associated with Affective Computing, with particular reference to the context of lower secondary schools (Holmes & Tuomi, 2022). In particular, the research seeks to move beyond a purely instrumental conception of emotional data, shifting towards an interpretative and relational perspective (Prinsloo & Slade, 2017). A primary objective is to analyse how the introduction of an 'emotionally aware' learning environment might impact students' emotional well-being and level of engagement, considering these dimensions not merely as quantitative indicators but as constitutive components of the educational experience (Fredricks et al., 2005, Järvelä et al., 2021). From this perspective, attention is focused on the possibility that emotional data, if properly interpreted, can support more conscious and meaningful participation processes, preventing the educational experience from being reduced to mere measurement (Selwyn, 2019). A second objective concerns the assessment of the development of collaborative and affective-relational skills within a citizenship education programme. In particular, the aim is to understand whether and how the use of technologies capable of stimulating reflection on emotional experiences can foster dynamics of cooperation, mutual recognition

and conflict management within the class group (Gillies, 2016, Panadero et al., 2018). This perspective forms part of the broader framework of social-emotional skills as the foundation of democratic participation and civil coexistence (Schonert-Reichl, 2017). At the same time, the research aims to explore the representations and perceptions of students and teachers regarding the use of emotionally sensitive technologies, with the aim of identifying any tensions between the technological and relational dimensions. This analysis aims to understand to what extent such tools are perceived as supporting the educational relationship or, conversely, as devices for controlling or simplifying the emotional experience (Holmes, 2020, Williamson & Eynon, 2020). Finally, specific attention is paid to the inclusive implications of the intervention, with particular reference to students with Specific Learning Disorders (SLD). The research seeks to investigate whether the integration of affect-oriented learning environments can help to support the well-being, participation and sense of belonging of these students, reducing any conditions of marginalisation and fostering full participation in class life (Cefai et al., 2021). Taken together, these objectives aim to contribute to a broader reflection on the pedagogical role of smart technologies, shifting the focus from the simple collection of emotional data to its interpretation in educational, relational and inclusive terms (Luckin et al., 2016, Selwyn, 2021;).

3. Tools

This study employs a mixed-methods approach, combining quantitative and qualitative components in order to capture the complexity of the relationship between emotional data and the educational relationship. This choice responds to the need to combine the systematic measurement of specific dimensions of the school experience with the interpretation of the meanings attributed by

the participants, in line with the multidimensional nature of affective and relational processes (Creswell & Plano Clark, 2007; Fetters & Molina-Azorin, 2020).

The quantitative component was designed to measure, before and after the intervention, certain key dimensions: school well-being, engagement and social-emotional skills. In line with the study's theoretical framework, these instruments were not used merely as measurement tools, but as functional indicators to capture changes in participation processes, the quality of relationships and students' emotional experiences (Järvelä et al., 2021).

The quantitative measures actually administered are described below on the basis of the documentation available from the study. However, the original research records do not provide complete information for all measures regarding the exact version used, item wording, number of items, response format, respondent, scoring procedure, normative interpretation or any adaptations made for the present sample. Consequently, where these elements cannot be reconstructed reliably, they are explicitly reported as undocumented rather than inferred retrospectively.

The following quantitative measures were used:

1. Student Engagement Scale: Based on the three-dimensional model of engagement (behavioural, emotional, cognitive), the scale measures student engagement using Likert-scale items. In this study, the tool was used to analyse pre–post variation in active participation, emotional involvement and cognitive investment in relation to the introduction of an emotionally aware learning environment (Fredricks et al., 2019). The available documentation identifies the measure as a Student Engagement Scale informed by the behavioural, emotional and cognitive

conceptualisation of engagement, but does not preserve sufficient information to establish the precise published version administered. The exact number of items, response anchors, scoring range, subscale computation, respondent instructions and any linguistic or contextual adaptations are therefore not documented with sufficient precision. The engagement score analysed in the study should consequently be interpreted as a study-specific indicator of school engagement rather than as a fully documented administration of a specific validated version of the scale.

2. Strengths and Difficulties Questionnaire (SDQ): The instrument, comprising 25 items divided into five subscales, was used to assess socio-emotional skills and behavioural difficulties. Particular attention was paid to the prosocial and relational dimensions, in relation to the objectives of developing collaboration and emotional regulation, including with regard to students with SLDs. The study documentation confirms the use of the 25-item SDQ and its five-subscale structure. However, it does not allow the specific respondent version adopted in the study to be identified with certainty, nor does it provide a complete record of the scoring procedure, the treatment of individual subscales, possible reverse-scored items, cut-off criteria or any adaptations applied to the instrument. The analyses presented in this paper therefore concern the scores generated within this study, particularly the prosocial dimension and the overall indicator of socio-emotional difficulties, rather than normative or diagnostic classifications derived from a fully documented SDQ administration.

3. School Well-being Scale: This scale enabled the investigation of the subjective perception of school well-being, including dimensions such as the quality of relationships, sense of security, satisfaction and perception

of support. The measure was used to describe changes in students' perceived school well-being and in their experience of the classroom as a supportive and inclusive environment. As with the engagement measure, the available documentation does not enable the exact published version of the School Well-being Scale to be established retrospectively. The number of items, response format, subscale structure, scoring procedure, respondent instructions, source version and any adaptations made for the present study are not sufficiently documented. The resulting score is therefore treated as an exploratory study-specific indicator of perceived school well-being rather than as evidence derived from a fully documented validated scale. Internal consistency was verified for all instruments using Cronbach's alpha (α), with observed coefficients of Engagement $\alpha = .84$, SDQ $\alpha = .79$, and Well-being $\alpha = .81$. These coefficients indicate adequate internal consistency of the scores obtained in the present sample. However, internal consistency alone does not establish the validity of an instrument, and the coefficients cannot compensate for the incomplete documentation of the specific versions, scoring procedures and adaptations employed. They should therefore be interpreted as reliability estimates for the scores analysed in this study, rather than as evidence that the measurement procedures themselves were independently validated. Because the exact administration and scoring characteristics of some of the quantitative measures cannot be fully reconstructed, the quantitative component is treated as exploratory. The measures are used to identify patterns of pre–post change and between-group differences within this specific educational context, rather than to provide psychometric validation of the instruments or definitive estimates of the underlying constructs.

The integration of these measures provided complementary quantitative indicators of engagement, well-being and socio-emotional skills, including a comparative analysis between students with and without SLDs (Panadero et al., 2018). Accordingly, the findings derived from these measures are interpreted in conjunction with the qualitative evidence and should not be generalised beyond the present sample without further validation using fully specified and prospectively documented measurement protocols.

The qualitative component was designed to explore participants' meanings, perceptions and experiences regarding the use of emotionally sensitive technologies, with a particular focus on the process of interpreting emotional data within the educational relationship. The following tools were used:

- semi-structured interviews with students, aimed at exploring their emotional experiences, their perception of the learning environment and the role attributed to technologies (Lee et al., 2021);
- interviews with teachers, aimed at investigating practices for interpreting emotional data and any tensions between the technological and pedagogical dimensions (Holmes & Tuomi, 2022; Williamson & Eynon, 2020);
- classroom observations, aimed at analysing relational dynamics, collaborative behaviours and modes of participation (Cohen et al., 2002).

The available documentation identifies these qualitative procedures and their general purposes but does not preserve a complete version of all interview guides, observation protocols or coding templates used during data collection. The qualitative component should therefore be understood as an exploratory interpretative strand intended to contextualise and deepen the patterns emerging from the quantitative data.

The qualitative data were analysed using thematic analysis following a systematic and reflective approach (Braun & Clarke, 2021), with the aim of identifying recurring patterns and interpretative categories. The analysis adhered to criteria of methodological rigour such as transparency, consistency and traceability of the interpretative process (Byrne, 2022; Nowell et al., 2017).

The integration of quantitative and qualitative data enabled us to capture the experiential and relational dimensions of the phenomena under investigation, providing complementary and convergent evidence rather than constituting, in itself, evidence of psychometric or construct validity (Creswell & Plano Clark, 2007; Fetters & Molina-Azorin, 2020). Accordingly, the mixed-methods integration is used here primarily to support an exploratory interpretation of the observed patterns and to generate hypotheses for subsequent studies employing fully documented and validated measurement procedures.

2. Sample selection

The sample was selected from a school located on the island of Ischia using non-probability convenience sampling, a methodologically justified choice in educational studies due to its accessibility and the opportunity to work in real-world contexts (Creswell & Creswell, 2017; Etikan & Bala, 2017). The study involved 110 students (aged 11–13) in the second and third years of lower secondary school. The analytical sample comprised 55 students in the experimental group and 55 students in the control group. Participants were enrolled in second- and third-year lower secondary classes; however, the original research documentation does not allow the exact number of classes involved or their distribution between the two study conditions to be

reconstructed with sufficient precision. Similarly, although the overall age range of the participants is documented, detailed group-specific distributions by age and gender are not available.

Assignment to groups (experimental vs control) was carried out using balanced allocation, in order to ensure homogeneity with regard to relevant variables (age, gender, SLD, initial engagement). The available study records indicate that age, gender, SLD status and baseline engagement were considered in seeking an approximately balanced composition of the two groups. With regard to SLD status, the eight students with certified SLDs were equally distributed between the two conditions (n = 4 experimental group; n = 4 control group). Baseline engagement was also highly comparable, with a mean score of 3.01 (SD = 0.42) in the control group and 3.04 (SD = 0.40) in the experimental group. These baseline engagement values are reported later in the quantitative analysis.

However, the available documentation does not provide a sufficiently detailed record of the operational sequence used to perform the balanced allocation—for example, whether participants were ordered, matched, stratified or sequentially assigned according to the balancing variables. Likewise, it is not possible to establish retrospectively with sufficient certainty whether the unit of assignment was the individual student or the intact class. Group-specific descriptive values for age and gender used during the allocation procedure were not preserved in the available research documentation. For this reason, "balanced allocation" should be understood here as a procedure aimed at obtaining broadly comparable groups rather than as a formally documented randomised or matched allocation procedure.

Consequently, although the two groups showed similar observed baseline characteristics, the absence of complete documentation of the allocation procedure does not allow selection bias or unmeasured baseline differences to

be excluded. Although this was not pure randomisation, the available evidence therefore does not permit the allocation procedure to be interpreted as equivalent to random assignment.

Both groups followed the same teaching programme in terms of content, timing and teachers. This procedural comparability was intended to reduce differences in educational exposure between the groups; however, it cannot by itself establish that subsequent between-group differences were caused exclusively by technological mediation. The sample included 8 students with SLDs, equally distributed across the groups, in line with an inclusive approach (Norwich, 2022; Snowling et al., 2020). Four teachers also participated, actively involved in the design and implementation of the intervention, following a grounded and collaborative research approach (Holmes & Tuomi, 2022).

Inclusion criteria

- age 11–13 years;
- regular attendance;
- voluntary participation with informed consent;
- enrolment in extended-day classes.

For students with SLDs, official diagnostic certification was required.

Overall, the sample is consistent with the study's objectives, albeit with limitations in terms of generalisability, linked to the specificity of the context. Given the non-probability sampling strategy and the incomplete retrospective documentation of the allocation unit and balanced-allocation procedure, comparisons between the experimental and control groups are interpreted primarily as exploratory. Accordingly, statistically significant differences are treated as evidence of associations and differential patterns observed under the two educational conditions, rather than as definitive estimates of a causal

effect or as validation of the intervention. Any causal interpretation should therefore be regarded as provisional and tested in future studies using prospectively documented randomised or cluster-randomised allocation procedures.

3. Educational Intervention

The educational intervention was designed in line with the theoretical framework, integrating emotional, relational and educational dimensions within the context of civic education (Biesta, 2020; Holmes & Tuomi, 2022).

General structure

Duration: 8 weeks.

Frequency: weekly.

Session duration: 2 hours.

Both groups worked on the same content (relationships, collaboration, emotions, conflict), differing only in the use of technology-mediated learning.

Control group

The control group followed an active but non-technology-mediated teaching approach, structured in three phases:

First Phase Activation: brainstorming and guided discussion to activate prior knowledge.

Second Phase Operational activities:

- dialogic lessons;
- text analysis;
- problem solving;
- cooperative learning (Johnson & Johnson, 2018);
- role-playing (Ruthotto et al., 2021).

Third Phase Review: Metacognitive reflection through discussion and writing (Panadero et al., 2018).

In this group, the emotional dimension remained implicit and mediated exclusively by the educational relationship (Selwyn, 2019).

Experimental group

The experimental group followed a similar structure, enriched by the integration of technologies inspired by Affective Computing.

First phase activation and emotional detection:

- emotional check-ins using digital tools (Mentimeter, Padlet);
- real-time data visualisation (Lee et al., 2021).

Second phase Operational activities:

- digital storytelling (Robin, 2016);
- digital role-playing and chatbots (ChatGPT);
- online collaborative activities (Google Classroom);
- ongoing emotional feedback.

At this stage, it is necessary to specify the role of the chatbot which, always under active teacher mediation to avoid interpretative automatisms (Selwyn, 2021), was used as:

- a cognitive tool;
- a reflective mediator;
- a relational simulator.

Third Phase Re-elaboration:

- metacognitive questionnaires (Google Forms);
- group discussion.

Key element: visualisation of aggregated emotional data, used as a subject for shared reflection.

Interpretative summary

The intervention frames technology not as a measuring device, but as a pedagogical mediator capable of:

- making implicit dynamics visible;
- supporting emotional awareness;
- facilitating processes of self-regulation and negotiation.

This approach is in line with contemporary models of social-emotional learning and citizenship (Holmes & Tuomi, 2022; Panadero et al., 2018).

4. Analysis of quantitative data

In the pre-test phase, the two groups (control and experimental) showed essentially comparable scores across all dimensions considered, indicating descriptive similarity between the groups at baseline on the observed measures, without implying full group equivalence or, by itself, establishing the

validity of the subsequent between-group comparisons. With regard to school engagement, the control group reported an initial mean of 3.01 (SD = 0.42), whilst the experimental group recorded a mean of 3.04 (SD = 0.40). At the end of the intervention, the control group showed a modest increase, reaching a mean of 3.19 (SD = 0.44), corresponding to a change of +5.98%, which was statistically significant but of moderate magnitude, $t(54) = 2.31$, $p = .024$. The experimental group, on the other hand, showed a more marked increase, with a post-test mean of 3.55 (SD = 0.36), equivalent to a change of +16.78%, which was highly significant, $t(54) = 6.14$, $p < .001$, with a medium-to-large effect size (Cohen's d = 0.85). The inter-group comparison in the post-test phase confirmed a significant difference in favour of the experimental group, $t(108) = 4.67$, $p < .001$. Similar differences emerge in relation to socio-emotional skills, as measured by the SDQ. With regard to the prosocial subscale, the control group moved from a mean of 6.18 (SD = 1.24) to 6.57 (SD = 1.19), representing an increase of +6.31%, $t(54) = 2.02$, $p = .048$. The experimental group showed a more substantial improvement, rising from 6.09 (SD = 1.21) to 7.11 (SD = 1.07), with a change of +16.75%, $t(54) = 5.21$, $p < .001$, and a medium-sized effect (Cohen's d = 0.72). At the same time, the total score for socio-emotional difficulties in the control group showed a modest reduction (from 14.26 to 13.61; −4.56%), which was not statistically significant, $t(54) = 1.94$, $p = .057$. In the experimental group, however, the decrease was more pronounced (from 14.11 to 11.98; −15.10%), with high statistical significance, $t(54) = 4.88$, $p < .001$. With regard to school well-being, the control group went from an average of 3.10 (SD = 0.45) to 3.26 (SD = 0.43), with an increase of +5.16%, $t(54) = 2.27$, $p = .027$. The experimental group, on the other hand, showed a more significant increase, from 3.08 (SD = 0.44) to 3.62 (SD = 0.38), equivalent to +17.53%, $t(54) = 6.02$, $p < .001$, with a medium-to-large effect size (Cohen's d = 0.88). Here too, the inter-group comparison in the post-test was significant, $t(108) = 4.51$, $p <$

.001, indicating a more positive perception of the relational climate and school experience in the experimental group. An additional descriptive analysis was conducted on students with SLDs (n = 8), distributed equally between the two groups. Given the small sample size, the results were interpreted in an exploratory manner. With regard to engagement, the control group showed an increase from 2.87 (SD = 0.38) to 3.00 (SD = 0.40), whilst the change was more pronounced in the experimental group (from 2.90 to 3.36). Similarly, school well-being increased from 2.97 to 3.13 in the control group and from 2.95 to 3.41 in the experimental group. Although not statistically significant, these trends indicate a more favourable descriptive pattern in the experimental group with regard to the participation and well-being of students with special educational needs; given the small subgroup size, these findings should be interpreted exclusively in exploratory terms. Overall, the quantitative results highlight a consistently more favourable pattern in the experimental group compared to the control group. The observed increases in engagement, school well-being and prosocial behaviour, together with the reduction in socio-emotional difficulties, indicate a more favourable pattern associated with the technology-mediated condition. These findings should be interpreted as exploratory evidence of an association between the use of technologies related to Affective Computing and differences in the quality of the educational experience and relational dynamics of the class group, rather than as evidence of a causal effect. Although promising, these findings must be interpreted with caution, taking into account possible confounding factors such as the novelty effect and the limited duration of the intervention. In this regard, future longitudinal studies may help to verify the stability of the effects and to isolate the contribution of the individual components of the intervention with greater precision.

5. Analysis of qualitative data

The qualitative analysis, conducted using a thematic analysis approach, enabled us to explore in depth the perceptions of students and teachers regarding the educational experience, with particular attention to the relationship between the emotional dimension, relational practices and technological mediation. An examination of the interviews and observations revealed several recurring themes: (a) the perception of the relational climate, (b) the role of emotional reflection in learning processes, (c) the value attributed to technology in educational mediation, and (d) the implications for inclusion, particularly for students with SLDs. In the control group, students described a positive experience centred primarily on direct interaction with peers and the teacher. The activities were perceived as useful opportunities to reflect on emotions and conflicts, but the affective dimension was often implicit, mediated mainly through oral discussion and the teacher's intervention. Whilst acknowledging the value of group work and role-playing, some students highlighted difficulties in openly expressing their emotional experiences, emphasising that participation was sometimes uneven. In this context, the educational relationship appears strongly centred on the teacher as the main mediator of the classroom atmosphere. In the experimental group, however, a more nuanced and reflective perception of the emotional dimension emerged. The digital tools used (emotional check-ins, digital storytelling, chatbots) were described as facilitators of personal expression, particularly in cases where direct verbalisation proved more complex. The students highlighted how visual and textual representations made the recognition and naming of emotions more accessible, whilst also fostering greater awareness of the collective dimension of emotional experience. The aggregated visualisation of data helped to make the classroom atmosphere

explicit, supporting processes of shared reflection. In this case, technology was perceived not as a substitute, but as complementary to the educational relationship. The comparison between the two groups thus highlights a significant difference in the ways of accessing and processing the affective dimension: implicit and verbally mediated in the control group; explicit, visible and also symbolically mediated in the experimental group. In particular, whilst direct dialogue prevails in the first case, in the second the possibility of 'representing' and 'visualising' emotions before sharing them emerges. Specific attention is given to students with SLDs. In the control group, their experience appears generally positive but is sometimes marked by difficulties in expression and participation, especially during moments of immediate verbalisation. In the experimental group, by contrast, digital tools were perceived as facilitators, allowing for diverse modes of expression (visual, written, symbolic) and fostering a more relaxed and structured participation. In this sense, technology appears to have played a compensatory role not only on a cognitive level but also on an emotional and relational one. Interviews with teachers confirm these dynamics. In the control group, the role of discussion and educational observation is valued, but difficulties in systematically capturing the experiences of all students also emerge. In the experimental group, however, digital tools were interpreted as useful aids for making the emotional climate visible and for broadening participation, whilst remaining aware of the need for constant pedagogical mediation. Some teachers also highlighted the risk of a simplified interpretation of emotional data, emphasising the importance of contextual interpretation. Overall, the qualitative analysis suggests that emotionally aware learning environments foster greater articulation, awareness and sharing of the emotional dimension. The educational value of

technologies does not lie in the mere collection of data, but in the possibility of transforming it, through the teacher's mediation, into an opportunity for dialogue, recognition and the shared construction of meaning.

6. Discussion

The findings of this research provide a basis for an in-depth examination of the relationship between emotional factors, educational relationships and the use of technology in lower secondary schools. The integration of quantitative and qualitative data highlights how hybrid and emotionally aware learning environments can have a positive impact on key aspects of the school experience, such as engagement, perceived well-being and the development of social-emotional skills, provided that such technologies are incorporated into a deliberate and critically oriented pedagogical design (Holmes & Tuomi, 2022; Järvelä et al., 2021). In particular, the improvement observed in the experimental group regarding engagement, prosocial behaviour and school well-being suggests that the ability to make the emotional dimension explicit, shareable and reflective fosters more conscious and qualitatively richer participation. From this perspective, technology is not merely an operational tool, but a mediating device that renders otherwise implicit dynamics visible, supporting processes of self-regulation, mutual recognition and the shared construction of meaning. This appears consistent with perspectives that emphasise how the educational value of data does not lie in its collection, but in its situated and relational interpretation (Selwyn, 2021; Williamson & Eynon, 2020). Qualitative analysis allows us to explore the nature of these processes in greater depth. In the experimental group, students demonstrated a greater ability to name, share and process their emotional experiences, thanks to the presence of tools that expanded the available channels of expression. Devices

such as the digital emotional check-in, the aggregated visualisation of emotions and interactions mediated by chatbots functioned as symbolic facilitators, making often latent dimensions of the school experience accessible and open to discussion. These findings are consistent with the literature on extended cognition and mediated practices, which recognises the role of artefacts in supporting complex cognitive and emotional processes (Kirsh, 2013). Particularly significant are the inclusive benefits observed among students with Specific Learning Disorders (SLD). The data suggest that the experimental environment fostered more accessible and differentiated forms of participation, thanks to the possibility of using multiple languages, visual aids and modes of expression less constrained by immediate verbal performance. From this perspective, technology did not act as a simplification of the task, but as an expansion of opportunities for access and expression, helping to reduce implicit barriers linked to the emotional and relational dimensions of learning (Rose & Meyer, 2002; Snowling et al., 2020). A key finding that emerged concerns the role of the teacher. The results confirm that the effectiveness of the intervention cannot be attributed deterministically to the presence of technological tools, but depends decisively on the quality of pedagogical mediation. Teachers played a fundamental role in interpreting the data, contextualising it and transforming it into opportunities for reflection and dialogue. This aspect appears crucial, as it highlights how technology can make certain dimensions of experience visible, but cannot replace the interpretative and relational processes inherent to education (Biesta, 2020; Selwyn, 2019). From this perspective, the findings help to move beyond both technocratic views, which attribute an autonomous transformative power to technology, and opposing positions that emphasise only its risks. Rather, it is clear that the central issue concerns the pedagogical quality of integration: when digital tools are used to promote reflection, awareness and dialogue, they can strengthen

the human dimension of education (Holmes & Tuomi, 2022; Selwyn, 2021). The placement of the intervention within the context of civic education proved particularly significant. The dimensions of collaboration, mutual recognition and conflict management provided a privileged context for observing the intertwining of emotion and citizenship. The results confirm that civic education, when understood in experiential and relational terms, represents a privileged space for the development of socio-emotional skills and for the construction of forms of responsible participation (Immordino-Yang et al., 2019; Panadero et al., 2018).

In summary, the research highlights how emotionally aware learning environments can constitute a significant resource for promoting well-being, engagement and inclusion. However, the main contribution lies in having shown that the emotional dimension acquires educational value only when it is transformed into an object of shared interpretation. From this perspective, it does not represent an end point, but a generative mechanism for rethinking the educational relationship in more reflective, situated and inclusive terms.

7. Conclusions

This study explored the potential of hybrid, emotionally aware learning environments in lower secondary schools, examining the relationship between emotional data, pedagogical mediation and the quality of the educational relationship. The results showed more favourable patterns in the technology-mediated condition with regard to participation, emotional awareness and some dimensions of the educational experience; however, given the methodological limitations of the study, these findings should be interpreted as exploratory associations rather than as evidence of the effectiveness of the intervention (Holmes & Tuomi, 2022).

A key finding concerns the role of the affective dimension within the educational processes examined. When emotions become the subject of explicit and shared reflection, the findings suggest that they may provide opportunities for reflection on students' well-being and the development of relational, ethical and citizenship skills. In this sense, emotional data, far from being reducible to a technical indicator, can be interpreted as a potential pedagogical resource within the specific context investigated (Immordino-Yang et al., 2019).

At the same time, the study *draws attention to* the value of pedagogical integration rather than technology itself. Teacher mediation appeared to play an important role in the educational activities examined, particularly in contextualising emotional data and supporting their shared interpretation, avoiding reductionist or deterministic tendencies (Biesta, 2020; Selwyn, 2021).

Despite the promising results, the study has some limitations. The sample, selected from a single school using convenience sampling, limits the generalisability of the results. The relatively short duration of the intervention allows for the observation of short-term *patterns of change*, without being able to assess stability over time. Particular caution is required with regard to students with SLDs. This subgroup consisted of only eight participants, with four students in the experimental group and four in the control group. The differences observed for this subgroup were descriptive and did not reach statistical significance. Consequently, no conclusions can be drawn regarding the effectiveness of the intervention for students with SLDs or regarding specific inclusive benefits attributable to the technology-mediated condition. The observed trends should be regarded exclusively as preliminary exploratory indications that may inform hypotheses for future research with adequately powered samples (Creswell & Creswell, 2017; Fetters & Molina-Azorin, 2020).

In light of these limitations, future research could explore various avenues: expanding the sample and diversifying contexts, conducting longitudinal studies, carrying out comparative analyses of the different technological tools used, and examining whether the descriptive patterns observed in students with SLDs can be replicated in larger and appropriately powered samples of students with different educational needs. The issue of teacher training also appears particularly relevant, understood as the development of the interpretative and planning skills necessary to critically integrate emotional data into educational practices (Williamson & Eynon, 2020).

In conclusion, the study's main contribution lies in drawing attention to the pedagogical question of how artificial intelligence and emotionally sensitive technologies are interpreted and used within educational relationships, rather than in demonstrating their effectiveness. Within the limits of this exploratory study, the findings indicate that critically mediated uses of such technologies may offer useful opportunities for investigating lived experiences, relationships and differences in school contexts, but further research based on more rigorous sampling, allocation and measurement procedures is required before effectiveness or inclusive benefits can be established. The educational challenge is therefore not to delegate the understanding of human experience to technology, but to use this data as an opportunity to explore, with greater awareness, the meaning of the educational relationship.

8. Implications for the design of hybrid learning environments

The results allow us to outline some relevant guidelines for the design of hybrid and emotionally aware learning environments.

Firstly, technology should be conceived as an integral part of the classroom's relational ecosystem, rather than as an additional or ancillary element. Its value

lies in its ability to make emotional and relational dimensions—which would otherwise remain implicit—visible and shareable, thereby fostering processes of awareness and reflection.

Secondly, it is essential to integrate the collection of emotional data with structured moments of pedagogical interpretation. Without such mediation, there is a risk of an automatic or reductive interpretation of the information, which would compromise its educational value.

A further design principle concerns multimodality. The possibility of expressing and reworking emotions through different languages (visual, narrative, digital, interactive) is a key element in supporting inclusion and participation, particularly for students with special educational needs (Rose & Meyer, 2002).

Finally, there is a need to maintain a balance between the technological and relational dimensions. In this balance, the teacher plays a central role as a mediator, interpreter and facilitator of meaning-making processes.

From this perspective, hybrid learning environments cannot be reduced to technologically enriched spaces, but must be understood as complex pedagogical contexts, in which the affective dimension becomes an explicit focus of design, reflection and educational practice.

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