HYBRID LEARNING SPACES AND INCLUSIVE EDUCATION: AN EXPLORATORY STUDY ON AUGMENTED LEARNING ENVIRONMENTS AND VIRTUAL WORLDS IN DADA SCHOOLS

SPAZI DI APPRENDIMENTO IBRIDI ED EDUCAZIONE INCLUSIVA: UNO STUDIO ESPLORATIVO SU AMBIENTI DI APPRENDIMENTO AUMENTATI E MONDI VIRTUALI NELLE SCUOLE DADA

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ABSTRACT
This exploratory research paper analyzes the use of virtual worlds and hybrid learning walls in a DADA school, highlighting how Phygital Learning fosters inclusion, motivation and the development of digital and soft skills. Participatory design of educational spaces shows the effectiveness of wellness-oriented immersive environments, according to the UDL framework.

Questo lavoro di ricerca esplorativa analizza l'uso di mondi virtuali e pareti didattiche ibride in una scuola DADA, evidenziando come il Phygital Learning favorisca inclusione, motivazione e sviluppo di competenze digitali e trasversali. La progettazione partecipata degli spazi educativi mostra l'efficacia di ambienti immersivi orientati al benessere, secondo il framework UDL.

KEYWORDS
Hybrid Learning Spaces; Phygital Learning; Inclusive Education; Virtual Wrolds; Eduverse
Spazi di Apprendimento Ibridi; Phygital Learning; Educazione Inclusiva; Mondi Virtuali; Eduverse

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Introduction

Contemporary schools are undergoing a profound transformation that requires rethinking traditional notions of space, time and learning. In DADA (the Italian acronym for *Didactics for Learning Environments*) schools, already oriented toward flexibility and subject specialization. There is a growing need to extend learning beyond physical boundaries by integrating virtual environments and phygital tools into a seamless educational continuum.

This exploratory research fits into that scenario, with the aim of investigating how the introduction of interactive teaching walls, enriched by QR codes that open immediate access to three-dimensional virtual worlds, can enhance DADA teaching, fostering an increasingly inclusive, adaptive and personalized approach. The concept of *Phygital Learning* (Chaturvedi et al., 2021) provides the theoretical framework for this hybridization process, in which the boundary between the physical and digital environments dissolves, resulting in fluid, immersive and participatory learning experiences.

The emerging concept of *Eduverse* (Filippone et al., 2023) also fits into this framework, an educational ecosystem based on the persistence of interactive virtual worlds, which do not simply replicate reality, but amplify it, making truly onlife teaching possible (Floridi, 2019): ubiquitous, connected, tailored to differences and capable of supporting the full expression of individual potential.

In addition to ensuring accessibility and customization according to the principles of *Universal Design for Learning* (UDL) (Rose & Meyer, 2006), Hybrid Learning Spaces born from the integration between Eduverse and the physical environment also take on a fundamental role in the development of Digital Soft Skills and Life Skills. With a view to orienting themselves towards the future, students are called not only to acquire disciplinary knowledge, but also to build transversal skills such as critical thinking, creativity, collaboration, effective communication skills and emotional self-regulation. These skills are now essential for active citizenship, future employability and, above all, for building a solid self-awareness (Boschi, 2023).

In this sense, Hybrid Learning Spaces are not simply technological environments, but spaces for personal well-being, for emotional and social growth, for the exploration of one's talents and vocations. The school that emerges thanks to the integration of phygital and Eduverse thus becomes a permanent orientation laboratory, in which each student can experiment, design, collaborate and

discover themselves within educational contexts rich in meaning and opportunities.

This research also aims to explore how these environments can not only enhance student learning, but concretely prepare them to be citizens and professionals capable of working and contributing to building the schools and educational contexts of the future. A school, therefore, that does not limit itself to preparing students for the future, but that makes them active protagonists of the future itself.

1. Theoretical framework

The construction of hybrid learning environments, in which the boundary between physical and virtual space dissolves, is based on a plurality of theoretical and pedagogical approaches that, intertwining, outline a new vision of contemporary school (Di Tore et al., 2021). Within this scenario, the concept of Eduverse and the paradigm of Phygital Learning represent two fundamental coordinates for understanding the transformation underway.

The concept of *Eduverse* (Filippone et al., 2023) introduces the idea of an immersive, three-dimensional and persistent educational ecosystem, in which the virtual space is not a simple replica of reality, but is configured as an autonomous environment, designed to foster authentic, multisensory and collaborative learning experiences. In the *Eduverse*, learning is achieved through direct interactions, manipulation of digital objects, creation of content and shared construction of meanings. The body and space, traditionally linked to physical materiality, are reinterpreted in a digital key, allowing new forms of presence, participation and expression.

In parallel, the *Phygital Learning* paradigm (Chaturvedi et al., 2021) proposes an integrated vision, in which physical space and digital space merge seamlessly. In phygital learning, the educational experience develops simultaneously on multiple levels, combining the corporeality and sociality of physical interaction with the expansion, flexibility and personalization offered by immersive technologies. This approach acknowledges that modern learning takes place in ubiquitous, dynamic and interconnected environments. (Sumanthi & Angelin Devakumari, 2022).

Eduverse and *Phygital Learning* converge in a shared vision of learning environments that transcend the binary between real and virtual, offering richer,

more accessible and more realistic educational experiences. The hybrid educational spaces that emerge from this integration do not limit themselves to introducing technologies into schools, but redefine the concept of education, focusing on student agency, the construction of transversal skills and the valorization of diversity.

In this perspective, the adoption of the *Universal Design for Learning* approach (Rose & Meyer, 2006) appears essential. UDL proposes to design learning environments capable of responding to the natural variability of students from the beginning, offering multiple ways of accessing content, expressing skills and emotional involvement. Hybrid Learning Spaces, enriched by *Eduverse* and Phygital Learning, embody this vision in an exemplary way, that is, the possibility of navigating, exploring, manipulating virtual environments allows each student to find the learning method best suited to their cognitive, emotional and motivational characteristics (Filippone et al., 2024).

The connection between hybrid spaces and UDL principles translates concretely into the possibility of supporting students with *Special Educational Needs* (SEN), *Specific Learning Disorders* (SLD) and, more generally, all students who require personalized and differentiated paths. Phygital environments offer tools to break down barriers, to multiply opportunities for expression and to strengthen motivation through meaningful, challenging and inclusive experiences (Efthymiou, 2023).

However, the transformative scope of *Hybrid Learning Spaces* goes beyond the dimension of accessibility and extends to the promotion of integral development of the person. In immersive and participatory learning environments, students are called to develop life skills that are fundamental to successfully addressing the challenges of contemporary society: critical thinking, creativity, problem solving, collaboration, effective communication, emotion management, resilience.

Similarly, continuous interaction with immersive digital environments fosters the development of increasingly crucial digital soft skills: the ability to navigate and build content in virtual worlds, management of one's digital identity, remote collaboration skills, computational thinking, and adaptability to new technological contexts (Filippone et al., 2023/I). These skills are no longer niche specialist skills, but constitute the basic language of active citizenship in the global digital society.

Hybrid Learning Spaces are therefore configured as privileged spaces for the construction of personal well-being and self-awareness, fundamental for self-orientation and planning one's own future where students are accompanied on a

growth path that goes beyond the acquisition of knowledge, encouraging the emergence of individual talents and the construction of an autonomous and conscious planning (Filippone et al., 2023/I).

2. Research objectives and questions

In light of the theoretical framework outlined, this exploratory research aims to investigate how the integration of three-dimensional virtual environments and interactive teaching walls, within DADA school contexts, can contribute to building Hybrid Learning Spaces that are truly inclusive, personalized, customizable and oriented towards the integral development of students.

First, we intend to explore the representations, perceptions and experiences of students and teachers regarding the use of *phygital* environments. Through qualitative tools such as focus groups, concept maps and learning diaries, the research aims to highlight how hybrid spaces are experienced and interpreted within the school, and what impact they have on participation, motivation and the sense of belonging to the educational community.

A second objective concerns the analysis of the contribution of *Hybrid Learning Spaces* in promoting school inclusion, with particular reference to the application of the principles of *Universal Design for Learning*. The research intends to evaluate how multiple access to content, diversification of expressive modes and multisensory involvement can effectively support students with *Special Educational Needs* and *Specific Learning Disorders*, promoting successful scholastic and experiential paths.

A further strategic objective is to investigate how hybrid environments can foster the development of *Life Skills* and *Digital Soft Skills* in students. In particular, we intend to analyze how the immersive and collaborative dimension of *Eduverse* can stimulate skills such as critical thinking, creativity, collaboration, effective communication, adaptability and management of emotions, all key skills for conscious orientation to the future and for global citizenship.

Finally, the research aims to outline an operational framework for the systematic design and implementation of *Hybrid Learning Spaces* in DADA schools. This model will have to integrate the theoretical principles of *Eduverse*, *Phygital Learning* and UDL, offering concrete guidelines for the construction of school environments capable of supporting inclusion, promoting personal well-being and

preparing students to become protagonists of their own growth path, inside and outside school.
From this perspective, the school is configured as a space not only for learning, but for authentic personal and collective empowerment, in which technology is placed at the service of the integral formation of the person, in an educational vision fully centered on well-being, participation and responsible orientation towards the future.

3. Methodology

3.1. Study design

The study was conducted in a lower secondary school that permanently applies the DADA model and has implemented PNRR (*National Recovery and Resilience Plan*) courses for both students and teachersto encourage the use of innovative technologies, in particular virtual worlds and augmented reality via visors. Not all students took part in these training courses: some had direct experience, while others engaged only occasionally or indirectly. Two experimental sections in which the Technology subject is taught through technology in CLIL (*Content and Language Integrated Learning*) have instead permanently integrated virtual worlds into curricular teaching.
As the school had not yet implemented hybrid interactive walls, the primary goal was to collect data to inform their participatory design, creating educational walls enriched with QR codes connected to the virtual worlds created in the PNRR paths.
The research adopts an exploratory mixed methodology design (*Mixed Methods*) of a parallel convergent type (Plano Clark, 2017; Creswell & Plano Clark, 2017), to explore how the perception, use and design of hybrid and augmented environments support inclusion, personalization and the development of transversal and digital skills.

3.2. Sample and context

The study sample included 863 students and 102 teachers.
The students are equally distributed between first (n=300), second (n=287) and third (n=276) classes, with a slight male prevalence (450 males, 413 females).

19.9% of the student sample is made up of students with *Special Educational Needs*, including those certified pursuant to Law 104/1992 (3.7%), with *Specific Learning Disorders* pursuant to Law 170/2010 (6.3%) and with socio-linguistic disadvantage pursuant to Ministerial Decree 27 December 2012 and subsequent Ministerial Decree 8/2013 (10%).
Teachers represented all major subject areas, with a strong presence of support teachers (n=36), reflecting the school's inclusive orientation.
In particular, 300 students participated in PNRR courses for immersive digital skills, 135 students (two experimental CLIL courses) used virtual worlds in ordinary teaching on a daily basis, and 25 teachers attended PNRR training courses for the design of augmented environments.

3.3. Experimentation phases

The study was structured into seven phases, integrating both quantitative and qualitative methods:

1. Sample profiling through descriptive questionnaire (personal data, training experiences).
2. Administration of validated questionnaires:
    - System Usability Scale (SUS) (Brooke, 1996),
    - Technology Acceptance Model (TAM) (Davis, 1989),
    - Perceived Inclusivity Scale (Booth & Ainscow, 2011),
    - UDL Scale (CAST, 2018).
3. Immersive learning experiences in virtual worlds and hybrid environments (VR viewers, QR codes, mobile devices).
4. Qualitative collection: focus groups (Morgan, 1997), concept maps (Novak & Canas, 2008), reflective diaries (Moon, 2006).
5. Elaboration of operational proposals for the shared design of hybrid walls.
6. Assessment of digital skills using the DigiComp 2.2 grid (Vuorikari et al., 2022), adapted from Filippone & Bevilacqua (2024).
7. Assessment of transversal skills through Life Skills Assessment Scale (LSAS) (Kennedy et al., 2014; Pearson et al., 2020).

This structure enabled the collection of in-depth data on usability, acceptance, inclusion, personalization, digital competencies and life skills.

3.4. Validity and data triangulation

The research followed a rigorous process of methodological triangulation, through the integration of standardized questionnaires and qualitative techniques (focus

groups, maps, diaries) and triangulation of sources, thanks to the comparison between CLIL students, PNRR students, untrained students, trained and untrained teachers. Particular attention was paid to validating ad hoc tools, with an emphasis on internal consistency checks and, where necessary, exploratory factor analysis. The consistency of the qualitative analyses was ensured through independent double coding of qualitative data, according to Braun & Clarke (2006), with intercoder comparison to guarantee reliability. The distinction between trained and untrained groups also strengthened internal validity, allowing significant comparative analyses on the impact of immersive technologies and innovative methodologies.

4. Data analysis

The analysis of the data collected during the experiment followed an integrated mixed methods approach, in line with the adopted parallel convergent design (Plano Clark, 2017; Creswell & Plano Clark, 2017). Quantitative and qualitative data were collected in parallel, analyzed independently and then integrated to provide a comprehensive and nuanced understanding of the emerging dynamics.

4.1. Quantitative analysis

As regards quantitative data, the results deriving from the administration of the SUS, TAM, Inclusivity, UDL Scale questionnaires were analysed, the statistical analysis of which was conducted through descriptive statistics measures (mean, standard deviation, median, mode, interquartile range).
Particular attention was paid to the analysis of digital skills detected through the DigiComp 2.2 grid (Vuorikari, Kluzer, & Punie, 2022), adapted following the protocol of Filippone & Bevilacqua (2024) through the analysis of digital competence profiles in five key areas, assessed using a 1-to-10 proficiency scale.
The analysis of transversal skills in relation to social interaction, problem solving, initiative, conflict management and respect for rules was conducted through the Life Skills Assessment Scale (LSAS) (Kennedy et al., 2014; Pearson et al., 2020).

For each analysis, a comparison was carried out between the subgroups of students (students participating in the PNRR courses, students attending the experimental CLIL course and other students) and teachers (teachers attending

the PNRR courses and other teachers) through an ANOVA and subsequent t-student test to assess statistically significant differences between groups.

4.2. Qualitative analysis

In parallel with the quantitative analysis, the qualitative data collected through focus groups, concept maps and reflective diaries were subjected to thematic analysis according to the methodology of Braun & Clarke (2006). Focus group transcripts were manually coded using open coding, revealing recurring themes such as the importance of augmented spaces and enhanced learner autonomy, the increase in intrinsic motivation, the experience of inclusion and the operational criticalities encountered in the use of technologies. Concept maps were analyzed through visual and semantic coding, identifying core symbols and cognitive connections articulated by students. The reflective diaries provided additional narrative material, which enriched the interpretation of the data that emerged.

4.3. Data integration

Quantitative and qualitative data were integrated through triangulation matrices, comparing numerical perceptions and narrative experiences to strengthen interpretative validity. This enabled the identification of clear future directions for implementing augmented learning environments, in line with UDL principles and Phygital Learning perspectives.

5. Results

Data from the four instruments provide a consistent and well-defined overview. The integration of virtual and hybrid environments in teaching, when accompanied by structured training, fosters highly positive perceptions in terms of usability, acceptance, inclusion and personalization of the educational experience.

5.1. System Usability Scale (SUS)

The data relating to the System Usability Scale highlighted a decidedly high perception of usability in all the groups analyzed. The average SUS scores were

above the acceptability threshold (>60) for all participants, with particularly high values recorded among CLIL students (M = 92.78; SD = 3.70), followed by PNRR students (M = 88.65; SD = 3.77) and PNRR teachers (M = 89.60; SD = 3.51). Although slightly lower, the scores of untrained students and teachers (M ≈ 79) still indicated a generally positive acceptance of virtual environments.
Analysis of individual SUS items shows high scores for positive statements and low scores for negative ones, indicating overall ease of use.
The analysis of variance (ANOVA) confirmed significant differences between groups [$F(4,960) = 297.97$, $p < 0.001$]. The subsequent pairwise comparisons (Welch's t-test) highlighted how intensive exposure to Virtual Worlds (CLIL group) is associated with a significantly higher perception of usability compared to the other groups, with evident positive impacts also for students and teachers trained through PNRR paths.

5.2. Technology Acceptance Model (TAM)

The data emerging from the analysis of the TAM scales, relating to Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), confirm and reinforce what was observed with the SUS. Also in this case, CLIL students report the highest mean values both for perceived usefulness (PU: M = 6.69; SD = 0.20) and for perceived ease of use (PEOU: M = 6.71; SD = 0.19).
Students and teachers trained through the PNRR paths also show very positive perceptions (PU ≈ 6.07; PEOU ≈ 6.14), while students and teachers who are not trained show slightly lower values (PU and PEOU ≈ 5.5). The ANOVA confirms statistically significant differences for both dimensions (PU: $F(4,960) = 354.51$, $p < 0.001$; PEOU: $F(4,960) = 360.10$, $p < 0.001$).
Also in this case, the paired t-tests indicate that daily engagement in Virtual Worlds (CLIL group) and structured training (PNRR) are key factors shaping perceptions of usefulness and ease of use, while the absence of training leads to less strongly positive perceptions.

5.3. Perceived inclusiveness

The analysis of the data collected through the questionnaire on perceived inclusiveness, inspired by the Booth and Ainscow model (2011), returned significant results in favor of hybrid environments. CLIL students recorded the

highest levels of perception of inclusiveness (M = 4.70; SD = 0.13), followed by PNRR students and teachers (M ≈ 4.10).
Untrained students and teachers reported lower scores (M ≈ 3.5), although still moderately positive. The ANOVA confirmed significant differences between groups ($F(4,960) = 1372.87$, $p < 0.001$), and pairwise comparisons highlighted that systematic experience in Virtual Worlds and specific training favor a stronger perception of school inclusiveness.
These findings suggest that accessible hybrid environments, when supported by guided instruction, can enhance students' sense of belonging, appreciation of diversity and perceived support.

5.4. Personalizing learning (UDL Scale)

Finally, the UDL questionnaire highlighted how the integration of immersive technologies in school contexts promotes the perception of more accessible, flexible and motivating learning.
CLIL students reported extremely high mean scores in the three pillars of the UDL model: Multiple Means of Representation (M = 4.72; SD = 0.27), Multiple Means of Action and Expression (M = 4.71; SD = 0.26) and Multiple Means of Engagement (M = 4.64; SD = 0.27). PNRR students and teachers also obtained positive values, although more contained.
Students and untrained teachers, while reporting overall favorable evaluations (M ≈ 3.5), are placed at lower levels. The ANOVA confirmed highly significant differences on all three pillars ($p < 0.001$), demonstrating that regular exposure to Virtual Worlds significantly enhances perceptions of personalized learning.

5.5. An overview of the results achieved

Taken together, the results obtained outline a highly coherent picture: hybrid and virtual learning environments, integrated within the DADA methodology and supported by targeted training paths, are perceived as highly usable, useful, inclusive and customizable.
Students and teachers who have had systematic immersive learning experiences report not only better perceptions of technology, but also a more intense sense of belonging and personal valorization. This highlights that technology, to produce a real educational impact, must be accompanied by a clear pedagogical design,

dedicated training paths and intentional planning oriented towards inclusion and well-being (Filippone et al., 2023/I).
The effective integration of virtual environments in teaching therefore represents not only a strategy of technological innovation, but above all a powerful lever to promote a more equitable, motivating education, capable of preparing students to face the challenges of future society with awareness and competence (Dato, 2021).

6. Discussion

The data collected through the System Usability Scale, the Technology Acceptance Model, the questionnaire on perceived Inclusivity and the UDL Personalization Scale converge in outlining an overall very positive picture with respect to the integration of virtual and hybrid environments in teaching, especially in schools implementing innovative approaches like the DADA model.
The high perception of usability and ease of use, highlighted in the SUS and TAM scores, confirms that when students and teachers are adequately trained and immersed daily in structured virtual environments, immersive technologies are perceived not as obstacles, but as enablers of learning. The CLIL group, systematically exposed to Virtual Worlds, recorded the highest scores in all the dimensions analyzed, demonstrating the fundamental importance of concrete and continuous experience in the acquisition of digital skills and in the acceptance of innovations (Isidori et al., 2024).
These results align perfectly with the theoretical assumptions of *Phygital Learning* (Chaturvedi et al., 2021) and *Eduverse* (Filippone et al., 2023), which conceive the educational environment as a fluid continuum between physical space and virtual space, capable of multiplying the opportunities for access, expression and involvement. No less relevant is the evidence that emerged on the front of perceived inclusiveness. Students and teachers trained through structured paths (in particular PNRR and CLIL ones) reported significantly higher perceptions of inclusion, valorization of differences and support. This data confirms that phygital environments, if designed according to the principles of *Universal Design for Learning* (Rose & Meyer, 2006), can serve as powerful drivers of inclusive education, capable of welcoming and valorizing the diversity of cognitive styles, skills and personal trajectories of students.

The UDL scale also highlighted how the integration of *Virtual Worlds* favors the perception of more personalized, flexible and engaging teaching. Students systematically exposed to phygital experiences reported increased opportunities for content access and expression, along with greater motivation and emotional involvement. This suggests that the adoption of immersive hybrid environments not only impacts learning efficiency, but also contributes to building school spaces oriented towards personal well-being, self-efficacy and conscious construction of the self (Dato et al., 2021).

It is important to note that the observed benefits are closely linked to the quality and intensity of training received. The untrained students and teachers, despite showing moderately positive perceptions, systematically placed themselves at lower levels than their trained colleagues. This confirms that technology alone is insufficient; what matters is intentional pedagogical design, which distinguishes superficial innovation from meaningful and sustainable transformation.

In terms of practical implications, the findings point to key directions for the future evolution of teaching practices:

- continuous training: it is essential to promote structured and systematic training programs for students and teachers on the conscious use of *Virtual Worlds* and *Hybrid Learning Spaces*;
- inclusive design: the adoption of virtual environments must be guided by UDL principles, ensuring accessibility, customization and multiple modes of participation;
- orientation towards well-being and personal growth: Hybrid Learning Spaces should be seen not merely as performance enhancers, but as environments that nurture life skills, digital soft skills and self-awareness;
- centrality of daily experience: continuous and daily exposure to Virtual Worlds is crucial: the mere occasional introduction of technologies does not generate comparable effects.

Finally, certain limitations of the study must be acknowledged. The exploratory nature of the study, the specific sample (DADA school) and the subjective self-assessment of the participants suggest the need to deepen the analyses with longitudinal studies, direct observations and objective measurements of the skills developed. It will also be important to extend the research to other school contexts, to verify the generalizability of the results obtained.

In In conclusion, research confirms that the intentional integration of *Virtual Worlds* and hybrid environments in teaching, supported by continuous training

and based on UDL principles, can radically transform the educational experience, making it more inclusive, personalized, motivating and future-oriented (Montanari, 2023). A school that adopts these paradigms not only prepares students for the challenges of contemporary society, but accompanies them in the conscious and happy construction of their life project (Dato et al., 2021).

7. Development of Life Skills and Digital Soft Skills

7.1. Life Skills

The analysis of the data collected through the Life Skills Assessment Scale highlighted significant differences in the levels of transversal skills between the groups analyzed, confirming the positive impact of the daily use of Virtual Worlds and innovative teaching methodologies. CLIL students, constantly exposed to immersive experiences, reported the highest average scores in all dimensions of the scale – Interacting with Others (IO), Overcoming Difficulties and Solving Problems (DP), Taking Initiative (TI), Managing Conflict (MC), Understanding and Following Instructions (UI) – reaching an overall average score of 4.70 (SD=0.20).
PNRR students and teachers, involved in continuous training courses on the use of educational technologies, also obtained significantly higher results than their untrained colleagues (PNRR Students: M = 4.13; PNRR Teachers: M = 4.22). On the contrary, non-PNRR students and teachers achieved lower values (M ≈ 3.51), indicating that the absence of a structured experience limits the autonomous development of life skills.
The analysis of variance (ANOVA) confirms highly significant differences between groups ($F(4,960)=724.00$, $p<0.001$), and the paired t-tests show that the acquisition of adequate training leads students and teachers to comparable levels of life skills. This data underlines the importance of designing learning environments that not only introduce innovative tools, but also promote their conscious and reflective use, in line with the indications of Pearson et al. (2020) and UNESCO (2021) on the requirements of a school oriented towards active citizenship and personal well-being.

7.2. Digital Soft Skills

The data collected on the Digital Soft Skills survey confirm the crucial role of daily exposure to Virtual Worlds in promoting advanced level transversal digital skills.

CLIL and PNRR students reported very high average scores (both M=9.30), positioning themselves at the top of the scale in the five areas observed: Information and Data Literacy, Communication and Collaboration, Digital Content Creation, Safety, and Problem Solving.

Particularly relevant is the data relating to Digital Content Creation and Problem Solving, areas in which students immersed daily in virtual environments demonstrate advanced and practical skills. PNRR teachers, thanks to specific training courses, are also placed in the excellence range (M=9.48), confirming that targeted training on digital skills can produce significant effects also in the teaching staff.

The ANOVA showed highly significant differences between the groups ($F(4,960)=5579.00$, $p<0.001$). Non-PNRR students and teachers, although reaching acceptable levels ($M \approx 6.00$), show a clear distance from the trained groups, confirming that without systematic experience and intentional teaching design (Ferrari, 2013; Damaševičius & Sidekerskienė, 2023), Digital Soft Skills tend to remain at basic levels.

The integration of virtual worlds in teaching, therefore, does not limit itself to promoting technical mastery, but promotes the development of transversal skills necessary to address the complexity of contemporary society, in line with the European framework DigComp 2.2 (Vuorikari et al., 2022).

8. Shared Design of Hybrid Teaching Walls: Focus Group Results

The analysis of qualitative data emerging from focus groups conducted with students and teachers confirmed the extremely positive perception of virtual environments as tools for innovation and educational inclusion. Students described the immersive experience in virtual worlds as deeply motivating, underlining the importance of being able to “enter” the contents through experiential, multisensory and dynamic methods.

The proposal to create hybrid educational walls, enriched with QR codes linked to diversified digital materials, was welcomed with enthusiasm. Students highlighted their preference for accessible multimedia content: short and interactive videos, podcasts, educational games and self-assessment quizzes, all designed to encourage independent and inclusive use. The need also emerged to provide paths with graduated difficulty, the use of distinctive colors to facilitate

orientation and the request for audio-accessible modes for students with visual or linguistic difficulties.
These data testify to a participatory conception of school: no longer an environment designed "for" students, but "with" students, in line with the principles of *Universal Design for Learning* (CAST, 2018) and contemporary inclusive pedagogies.

9. Operational output: guidelines for the design of Hybrid Walls

From the synthesis of the needs that emerged in the focus groups, it is possible to outline some operational guidelines for the shared design of hybrid teaching walls. The walls must be organized thematically, divided into easily recognizable sections thanks to the use of distinctive colors and intuitive symbols, to facilitate visual orientation and make the use of the contents immediate. The QR codes, the central element of the project, must be placed in a visible and accessible way, with clear color contrasts and adequate dimensions, accompanied by simple and immediate instructions to guarantee usability even for students with visual or linguistic difficulties.
Digital materials linked to QR codes will be diversified and short-lived, favoring dynamic formats such as interactive videos, podcasts, concept maps and educational games, capable of stimulating the interest and active participation of students. Particular attention will be paid to universal accessibility: the contents must always be available in audio or subtitled mode and organized according to paths of graduated difficulty, clearly indicated by explanatory symbols.
The design also includes the integration of augmented reality elements, explorable through simple viewers or mobile devices, to create immersive experiences that promote dynamic interaction between physical space and digital environment (Filippone et al., 2023/I). In a broader educational perspective, the entire design system will be oriented towards the well-being and development of student autonomy, promoting discovery, critical thinking, creativity and intrinsic motivation (Dato et al., 2021).
The hybrid walls, designed starting from these indications, do not simply represent a teaching support, but are configured as true dynamic educational ecosystems, capable of promoting inclusion, personalization and scholastic well-being, in full harmony with the paradigms of Phygital Learning and Eduverse.

10. Design and construction of prototypes of Hybrid Teaching Walls

At the end of the participatory design process, the graphics company in charge[1] created the first prototypes of the hybrid teaching walls, translating the indications that emerged in the focus groups with students and teachers into concrete environments. The implementation focused on four thematic laboratories (Mathematics, Science, Technology and Languages), each designed to respond to the educational, aesthetic and functional needs collected during the exploratory phase, with the aim of continuing with the creation of all the thematic and disciplinary areas.

The Mathematics Laboratory (Figure 1) was designed to make the complexity of scientific knowledge visible and accessible. The walls feature hand-drawn formulas, graphs and geometric figures, on a blue gradient background that recalls the depth of an abstract and luminous space. The "sketch" approach gives a human and playful tone to mathematics, breaking the perception of rigidity often associated with the discipline and promoting a creative exploration of scientific knowledge.



Figure 1. 3D three-dimensional representation of the graphic design and realistic adaptation on the physical walls of the school for the Mathematics Laboratory

In the Science Lab (Figure 2), the graphic concept is geared towards fostering curiosity and interdisciplinary understanding. The visual elements, neatly

[1] The graphic design company, specialized in graphic design, institutional and promotional communication, branding and production of materials for print and digital, charged with creating what was co-designed within this experiment is "CallPrint – Communication designers" by Alessio Caposiena, San Severo, Foggia (Italy).

separated on a uniform blue background, illustrate key concepts in physics, chemistry and biology with soft strokes and pastel colors. The use of recognizable icons such as the globe, microscope or atom stimulates clear and engaging visual learning, creating a friendly and accessible environment for all students.



Figure 2. 3D three-dimensional representation of the graphic design and realistic adaptation on the physical walls of the school for the Science Laboratory

For the Technology Laboratory (Figure 3), a high-tech style has been adopted that recalls robotics and digital innovation. The cold and metallic tones, together with the presence of central graphic structures inspired by computer networks, immediately project the viewer into a futuristic universe of technological precision. This space aims to convey the sense of efficiency, progress and global connection, with a strong contemporary visual impact.



Figure 3. 3D three-dimensional representation of the graphic design and realistic adaptation on the physical walls of the school for the Technology Laboratory

Finally, the Language Lab (Figure 4) was designed to immerse students in a total linguistic experience, through a pop, energetic and oversized visual concept. The key words in English (speak, listen, think, play) stand out on the walls with bold characters and bright colors, transforming the language not only into an object of study, but into an experiential environment to be lived daily. The use of 3D elements, comics, emojis and sound symbols further strengthens the immersive perception, making language learning dynamic, participatory and memorable.



Figure 4. 3D three-dimensional representation of the graphic design and realistic adaptation on the physical walls of the school for the Language Laboratory

For each laboratory, two distinct prototypes were created: a 3D representation of the graphic design and a realistic adaptation on the physical walls of the school, in order to concretely simulate the environmental effect and verify the coherence between the project and the real educational context.

It is essential to underline that this design was not born from an exclusively technical process, but is the fruit of an authentically participatory path. Students had an active and central role in defining the contents, the visual organization, the choice of materials and the methods of access to digital resources. Their proposals, collected, elaborated and translated into operational solutions, testify to the validity of an educational approach that puts the voice of students at the center, in line with the principles of *Universal Design for Learning* (CAST, 2018) and with the DADA methodology.

Furthermore, the integration of QR codes on the walls is not purely symbolic: each QR code actually refers to the virtual worlds developed and experimented by the students themselves within the PNRR paths. In this way, a real continuity is created between physical and digital experience, between real and immersive learning, according to the Phygital Learning model theorized and applicable in the

DADA educational context. The school thus becomes a dynamic ecosystem, where real and virtual intertwine to build more accessible, motivating and inclusive learning experiences (Gesthuizen et al., 2025).
This concrete design therefore represents a fundamental step towards the creation of truly student-centered hybrid learning spaces, capable of responding flexibly and innovatively to the educational challenges of the future.

Conclusions

This exploratory research has confirmed that the integration of virtual environments, hybrid teaching walls and augmented learning methodologies represents an effective strategy to innovate the contemporary school, making it more inclusive, personalized, flexible and future-oriented. In a school context already predisposed to change such as the DADA one, the introduction of *Virtual Worlds*, QR codes and shared design of physical-digital environments has produced significant positive impacts on multiple educational dimensions.
The data collected through quantitative and qualitative tools have highlighted that the perception of usability, usefulness and accessibility of phygital environments is extremely positive, especially among students and teachers who participated in structured training courses. The daily experience in virtual worlds has consolidated not only technological familiarity, but has also favored the strengthening of essential transversal skills: Life Skills - such as the ability to solve problems, collaborate, manage conflicts, take initiatives - and Digital Soft Skills - such as the creation of digital content, online collaboration and critical thinking in virtual environments.
The research has also shown that the participatory design of hybrid environments, based on active listening to students' needs and their creative involvement, can translate into concrete solutions capable of making the school environment more motivating, accessible and engaging. The prototypes created for the Mathematics, Science, Technology and Language laboratories demonstrate how a shared educational vision can take concrete form, transforming the school into a dynamic ecosystem in which the real and the virtual merge seamlessly.
The direct connection between the QR codes on the walls and the virtual worlds built by the students themselves was particularly significant, an integration that becomes an authentic example of Phygital Learning, laying the foundations for truly immersive and onlife teaching, as envisaged by the Eduverse concept.

Learning is no longer limited to a physical space or a defined school time, but becomes an extended, ubiquitous and personalized experience.
The methodology adopted, inspired by *Universal Design for Learning*, proved to be fundamental in ensuring that technological innovation went hand in hand with educational inclusion. The hybrid teaching walls designed respond not only to the needs of accessibility and differentiation of paths, but also to the need to stimulate the well-being, autonomy and protagonism of students.
The research results, although limited to a specific experimental context, provide valuable insights for rethinking the future of education. They suggest that the intentional adoption of immersive technologies, supported by continuous training and inclusive teaching practices, can represent a powerful lever to transform school into a space for personal growth, for building life skills and for conscious preparation for the challenges of a complex and global society.
Looking ahead, it will be important to continue implementing and observing these hybrid environments on a larger scale, assessing their long-term impact on learning, school inclusion and the development of key skills for the 21st century.
This study confirms that a school blending the real and virtual, technology and emotion, innovation and inclusion is not only feasible but essential for shaping the future of education.

Author contributions

A.F. conceptualized the study, supervised the project, administered project activities, developed the methodology, designed the virtual worlds, performed data analysis, managed resources, and wrote introduction, methodology, results and discussion sections; M.E.D.C. conducted literature review focused on pedagogical aspects and UDL framework, contributed to resource management, and participated in manuscript editing. Both the authors reviewed and approved the final version of the manuscript.

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