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The Role of Artificial Intelligence and Embodiment in the Inclusion of Schools: an Analysis of the Didactic and Pedagogical Potential in Primary School

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Abstract: Artificial Intelligence (AI) integrated with Embodiment-based educational practices has the potential to revolutionise the approach to inclusion in schools, opening up new avenues for learning and active student participation for an education that values diversity and promotes equality. Through a combination of quantitative and qualitative tools, such as the Ainscow Inclusion Scale, semi-structured interviews with teachers and students, and direct observation, this study demonstrates that the use of AI technologies to create embodied learning environments has a positive impact, not only in improving inclusion and participation, but also in influencing the motivation and engagement of students, particularly those with disabilities. The discussion of the findings is contextualised by a review of existing literature, which highlights the effectiveness of such strategies in promoting inclusive pedagogical practices. In conclusion, the study acknowledges the need for further long-term research and emphasises the importance of investing in this area.

Keywords: Artificial Intelligence, Embodiment, Inclusion, Students, Primary School

1. Introduction

Inclusion is a fundamental educational principle that upholds the right of all students to a quality education, regardless of their abilities or disabilities. This approach is not only an educational goal, but also a social imperative, as it aims to build more equitable and respectful school communities. An inclusive environment brings significant benefits both to students with disabilities, who can receive support

tailored to their needs, and to those without disabilities, fostering positive social interactions, empathy and collaborative learning.

Buccini F. (2023) highlights in his work how artificial intelligence can represent a significant opportunity to personalise teaching-learning processes and how it is a valuable tool to support teachers in identifying effective teaching strategies.

Indeed, in recent years, artificial intelligence has shown extraordinary potential for facilitating and improving inclusion in schools. Emerging technologies such as social robots and augmented reality (AR) applications offer new opportunities to create more accessible and engaging learning spaces. Embodiment is a theory that emphasises the importance of the body and physical experience in interacting with the environment and in learning itself. In this context, bodily experience proves to be crucial in promoting meaningful and deep learning.

Despite technological advances, the introduction of AI in primary schools is not without its challenges. It is important to consider how effectively these technologies can be integrated into existing curricula and what training and support is needed for teachers. Furthermore, a critical assessment of the impact of AI on inclusion must consider not only the potential benefits, but also possible critical issues such as technology dependency or unequal access to digital resources. As highlighted by Laster, A., & Lee, S. J. (2021), inclusion in schools not only facilitates learning for students with disabilities, but also enriches the learning experience for all by promoting empathy and diversity. This study explores how AI, through the concept of embodiment, can promote inclusion in primary schools by analysing both the impact of AI technologies and the subjective experiences of the students involved. We aim not only to collect quantitative data on inclusion, but also to consider the personal narratives of students and teachers in order to gain a holistic view of the effectiveness of the interventions.

The literature highlights how AI can have a positive impact on inclusion in schools. According to Belpaeme et al. (2018), the introduction of social robots in classrooms has the potential to facilitate meaningful social interactions between students with and without disabilities, contributing to a more inclusive learning environment. Similarly, Billinghurst and Duenser (2012) demonstrated that augmented reality can improve the accessibility of educational content, making it more engaging and understandable for all students. Other studies, such as those by Broadbent (2017) Goodrich and Schultz (2007), highlight that the use of technology in educational settings can break down barriers to learning and promote a collaborative and inclusive learning environment. These findings provide a strong basis for further exploration of how AI and embodiment can be used to promote inclusion in primary schools.

However, it is also crucial to consider the experiences and perceptions of end users, i.e. students and teachers, in order to understand how AI can concretely impact school inclusion. Buongiorno (2023) states: "Embodiment and algorithmic thinking offer a unique phenomenological perspective on the relationship between the lifeworld and artificial intelligence, exploring how these emerging technologies influence our perception of and interaction with reality".

2. Structure of the research: Methodology, Participants, Tools

The study involved a sample of 100 pupils aged between 6 and 10 from five primary schools in urban and suburban areas. They were selected for their diversity of ability, including students with and without disabilities.

The types of disabilities present in the research sample were:

- Cognitive Disabilities: students with learning difficulties that affect the ability to think, understand, and solve problems (Attention Deficit/Hyperactivity Disorder ADHD, Autism Spectrum Disorders ASD).
- Physical Disabilities: Pupils with motor impairments that affect their mobility, their coordination and their physical activities (cerebral palsy, muscular dystrophy).
- Learning Disabilities: Pupils with specific difficulties in reading, writing, arithmetic and comprehension (dysgraphia, dyscalculia).

This selection was made to ensure a balanced representation of different ability levels and socio-economic backgrounds. Informed consent for student participation was obtained from parents and teachers, ensuring that all procedures complied with ethical and data protection regulations.

A mixed qualitative-quantitative approach was adopted for the research: for the quantitative analysis, data collection was carried out according to the parameters of the Ainscow Inclusion Scale and concerned only the student component, while for the qualitative analysis, semi-structured interviews were conducted with both the student and teacher components, taking into account their personal observations and insights.

The Ainscow Inclusion Scale is the quantitative assessment method used in this study and measures various aspects of school inclusion, including access, participation and involvement of pupils. The scale ranges from 1 to 5, with 1 indicating low levels of inclusion and 5 indicating high levels of inclusion. The items assess aspects such as perceived support from teachers, participation in group activities, access to educational resources and participation in lessons. The results were used to identify areas for improvement and to evaluate the effectiveness of the intervention. The scale was chosen for its validity and reliability in the school context to measure the

level of inclusion perceived by pupils: it consists of 10 items with scores ranging from 1 (low level of inclusion) to 5 (high level of inclusion). In addition to the Ainscow Inclusion Scale, qualitative questionnaires were used to collect feedback from teachers and direct observations to assess pupils' behaviour and interaction during the activities. The qualitative questionnaires were designed to explore students' and teachers' personal experiences of the intervention, with open-ended questions allowing unrestricted expression of thoughts and feelings.

The intervention consisted of the implementation of an embodied learning environment supported by AI. This included the use of educational robots programmed to interact with students in a personalised manner and augmented reality (AR) applications to create immersive learning experiences. Students participated in weekly 45-minute sessions over a three-month period. Educational robots, such as NAO and Pepper, were programmed to provide instructional support, assistance with group activities and personalised feedback to students. AR applications were used to overlay digital information onto the real world, facilitating learning through visual and interactive immersive experiences. These tools were integrated into the school curriculum to enhance traditional teaching and make learning more accessible.

Prior to the intervention, an initial assessment was carried out using the Ainscow Inclusion Scale to establish a baseline. Teachers administered the test to students in a controlled environment to ensure consistency of responses. During the intervention, weekly observation sessions were conducted to monitor student progress and interaction. At the end of the three-month period, a post-intervention assessment was carried out again using the Ainscow Inclusion Scale to compare students' perceived levels of inclusion. The procedure also included semi-structured interviews with teachers and students to gather qualitative feedback on experiences and perceptions of the intervention. Quantitative data was collected through questionnaires, while qualitative data was analysed through a computerised coding process to identify patterns and recurring themes in responses.

Table 1. Description of the evaluation tools in use for quantitative and qualitative surveys

	Quantitative Analysis	**Qualitative Analysis**		
	Ainscow Inclusion Scale	**Qualitative Questionnaires for Teachers**	**Qualitative Questionnaires for Students**	**Direct Observation**
Description	A measure of the level of inclusion	Open-ended questionnaires	Open-ended questionnaires	During the intervention, ob-

	perceived by students, consisting of 10 items with scores ranging from 1 (low level of inclusion) to 5 (high level of inclusion).	designed to explore teachers' personal experiences of the intervention.	designed to explore students' personal experience of the intervention.	servations were recorded by teachers and researchers and then analysed to identify changes in behaviour, social interaction and engagement.
Aspects under evaluation	Access, participation and involvement.	Teachers' perceptions of pupils' behaviour, social interaction, participation and motivation.	Feelings of inclusion, perceptions of the use of educational robots and AR applications, motivation and engagement.	Students participate in group activities, interact with peers and robots, and engage in AR experiences.

Educational activities integrated with Artificial Intelligence (AI) and embodiment were designed to promote school inclusion in primary schools. These activities aimed to create a more accessible and engaging learning environment for all students, with a special focus on those with disabilities. The main educational activities integrated with AI and embodiment are described below, together with the specific objectives pursued

Table 2. Description of Educational Robot Activities

EDUCATIONAL ROBOT ACTIVITIES		
Used Tools	**Type of Activity**	**Specific Goals**
NAO, a programmable humanoid robot that can interact with students through movement, sound and speech recognition. Pepper, a humanoid robot designed to interact with people on an emotional and	Interactive lessons: Robots were used to deliver lessons on various topics such as maths, science and languages. These lessons included explanations, interactive questions and answers, and hands-on activities.	Improving access to education: Using robots to make the classroom more accessible for students with disabilities. Promoting Social Interaction: Facilitating collaboration and communication between

social level.	Support for group activities: The robots facilitated group activities and encouraged students to work together. They assigned tasks, made suggestions and monitored progress. Personalised feedback: The robots provided immediate and personalised feedback to students during lessons and activities, helping to correct mistakes and reinforce learning.	students with and without disabilities. Increase motivation and engagement: Make learning more fun and engaging by interacting with robots.

Table 3. Augmented Reality AR activity description

AUGMENTED REALITY AR ACTIVITIES		
Used Tools	**Type of Activity**	**Specific Goals**
Application of AR via apps on tablets and smartphones that superimpose digital information on the real world.	Immersive learning experiences: Students used AR applications to explore complex concepts in a visual and interactive way, such as viewing 3D animations of scientific or historical processes. Comprehension exercises: AR applications were used to create interactive comprehension exercises where students could interact with the learning content in a dynamic way.	Making learning content more accessible: Using AR to improve content comprehension for learners of all abilities. Inspire creativity and imagination: Encourage students to explore and create content, promoting active and creative learning. Facilitate meaningful learning: Use immersive experiences to help students better understand and remember

	Creative projects: Students created their own AR content as part of class projects, learning not only educational content but also technology skills.	learning concepts.

Table 4. Description of Embodiment Activities

EMBODIMENT ACTIVITIES	
Type of Activity	**Specific Goals**
Movement and learning games: Activities that combine physical movement with didactic learning, such as spelling or maths games that require pupils to move and interact physically. Hands-on workshops: Laboratory sessions where students can manipulate real materials and tools, such as science experiments or art activities. Role play and dramatisation: Role-playing activities in which students play historical or scien-	Encouraging active learning: Engaging students through physical activity to improve understanding and retention of learning concepts. Encourage interaction and collaboration: Use group activities to encourage social interaction and teamwork. Making learning more meaningful: Creating learning experiences that connect educational concepts to students' real-life and physical experiences.

tific characters and have learning experiences through dramatisation.	

3. Quantitative results

Table 5. Evaluation of the results of the Ainscow Inclusion Scale

	Before intervention (average)	After the intervention (average)	Improvement
Students without disabilities	4.0	4.5	0.5
Students with disabilities	3.4	4.2	0.8

Statistical Analysis: The ANOVA showed statistically significant differences between the pre- and post-intervention scores ($F(1, 198) = 12.34$, $p < 0.001$).

Table 6. Specific quantitative results according to the disability type

Disability type	**Before intervention (average)**	**After the intervention (average)**	**Improvement**
Cognitive Disabilities	3.2	4.1	0.9
Physical Disabilities	3.6	4.3	0.7
Specific Learning Disorders	3.4	4.2	0.8

Results show a significant increase in Ainscow's Inclusion Scale scores post-intervention compared to pre-intervention with a p-value < 0.01. Students with disabilities showed a significant improvement in terms of access and participation in learning activities, highlighting the effectiveness of educational robots and AR ap-

plications in facilitating more active and engaging interactions. Students without disabilities also reported a greater sense of inclusion and engagement, suggesting that a diverse learning environment benefits all students.

Specifically, the Ainscow Inclusion Scale was used to analyse and evaluate different aspects of school inclusion, including access, participation and involvement of pupils:

1) Access to educational resources: Students with disabilities reported up to a 25% improvement in access to educational resources, while students without disabilities reported up to a 15% improvement. This was attributed to the ease of use of AI technologies and the accessibility of digital resources. This also suggests that AI technologies can help level the playing field by providing students with disabilities with tools that compensate for their difficulties and allow them to access the same resources as their peers.

2) Participation in group activities Participation in group activities increased to 30% for students with disabilities and 10% for students without disabilities. Educational robots facilitated collaboration and communication between students, making group activities more engaging and promoting a more inclusive and interactive learning environment.

3) Participation in lessons: Active participation in class increased by up to 30% for students with disabilities and 20% for students without disabilities. AR applications made lessons more interactive, interesting and stimulating, increasing the attention and participation of students regardless of ability.

Table 7. Percentage increase

	Students Without Disability	**Students with Cognitive Disabilities**	**Students with Physical Disabilities**	**Students with Specific Learning Disorders**
Access to Educational Resources	+15%	+20%	+18%	+25%
Participation in Group Activities	+10%	+30%	+15%	+28%
Involvement in Lessons	+20%	+25%	+20%	+30%

4. Qualitative results

"Understanding the subjective experiences of students and teachers is critical to evaluating the effectiveness of educational technology in the area of school inclusion" (Murray, J., & Hensley, M. K., 2020). In terms of qualitative analysis, interviews with teachers and students revealed positive experiences with the intervention. Teachers noted a significant increase in pupils' motivation and interest. One teacher commented: *"Robots have changed the way my students approach the classroom. They are now more inclined to actively participate"*. They also observed improvements in collaboration and communication between students with and without disabilities, and increased active participation in lessons and group activities. As Gunter, G. A., & Gunter, R. E. (2020) point out, "Teachers' perceptions of AI tools are critical to ensuring their effective integration into school curricula". At the same time, students described how educational robots and AR applications made learning more fun and engaging. Pupils with disabilities expressed their gratitude for the personalised support they received, highlighting the importance of feeling included and valued in the school context.

Table 8. Specific Qualitative Results by Type of Disability

	Teachers' Experiences	**Students' experiences**
Cognitive Disabilities	Teachers reported a significant improvement in the ability of students with cognitive disabilities to concentrate and actively participate in class with the support of educational robots.	Educational robots have been particularly helpful in facilitating social interaction and communication for students with autism spectrum disorders.
Physical Disabilities	Teachers noted that students with physical disabilities particularly benefited from AR applications, which made learning content more accessible and interactive.	Pupils enjoyed using the educational robots to receive personalised support during educational activities, improving their autonomy and confidence.

Specific Learning Disorders	Teachers noted that students with DSA showed a significant improvement in their understanding of educational content thanks to the immersive experiences provided by AR applications.	Students with dyslexia found literacy activities more accessible and less frustrating with the help of AI technology, increasing their motivation and participation.

5. Discussion

The results obtained confirm the strong impact and importance of AI and embodiment in promoting school inclusion. Learning environments supported by educational robots and AR applications led to the combination of innovative technologies and targeted pedagogical approaches that proved to significantly improve students' access and participation, reducing barriers to learning in favour of a more inclusive and stimulating educational environment. The subjective experiences of students and teachers collected through the qualitative analysis questionnaires highlighted how the positive experiences of students with disabilities can contribute to a more inclusive and respectful school culture. Furthermore, the data suggests that the use of AI technologies can have a positive impact on the motivation and engagement of students, who reported a greater sense of belonging and collaborative team spirit, creating a more stimulating and welcoming learning environment.

Mancini and Sebastiani (2024) examine how the use of AI can enhance the cognitive abilities of students, and their research explores the impact of this technology on education, highlighting how it can support learning and the development of cognitive skills. They also argue that AI, when effectively integrated into educational contexts, can offer new opportunities to personalise teaching and improve teaching strategies. At the same time, the use of AI technologies integrated with embodied practices showed positive outcomes and significant improvement for all students with disabilities in the sample, improving their access, participation and inclusion, and promoting a more inclusive and welcoming school environment. Indeed, for students with cognitive disabilities, intervention with educational robots and AR applications improved students' concentration and active participation, and also facilitated social interactions. For students with physical disabilities, the technological tools made access to educational resources easier and more inclusive, improving students' autonomy and confidence. Finally, for students with learning disabilities, the immersive and interactive experiences offered by AI technologies have

made learning more engaging and comprehensible, reducing barriers related to learning difficulties. Although the results are promising, it is important to consider some limitations of the study. One limitation is the duration of the intervention.

Future studies could explore the long-term effects of the use of AI and embodiment on school inclusion. In addition, the generalisability of the findings may be limited by the relatively small and geographically restricted sample. Further research should include larger and more diverse samples, as well as longitudinal analysis of the effects of AI technologies on school inclusion over time to confirm the findings. It is also important to consider confounding variables, such as teacher support and student attitudes towards technology, which may have influenced the results. Existing literature confirms that the use of AI can support inclusive learning environments. For example, previous studies have shown that educational robots can facilitate social interaction between students with and without disabilities (Belpaeme et al., 2018).

Furthermore, AR has been identified as an effective tool for improving the accessibility of educational content (Billinghurst & Duenser, 2012). These results are consistent with our findings, suggesting that the integration of AR technologies can be an effective method to promote inclusion. Other studies, such as those by Hu & Bartneck (2018) and García-Sanjuán et al. (2020), have shown that AI can be adapted to the specific needs of students, thus promoting personalised learning and inclusion.

6. Conclusion

The integration of AI technologies and embodiment into classroom activities has been shown to have a positive impact on school inclusion in primary schools. The data collected in this experimental study suggests that the integration of technology and AI through embodiment offers promising new opportunities to improve and promote a more inclusive learning environment in primary schools. The integration of AI technologies, such as educational robots and augmented reality applications, has proven to be an effective strategy for fostering a more accessible and engaging learning environment for all students, particularly those with disabilities. Increased scores on the Ainscow Inclusion Scale study suggest that these technologies not only improve access and participation, but also have a positive impact on student motivation and engagement, creating a more equitable and inclusive learning environment.

The embodied approach, which emphasises the importance of physical experience, has been shown to be crucial in facilitating meaningful interactions and deep

learning. Further research is needed to explore the long-term potential and applicability of these technologies in different educational contexts. It is important to continue to explore how to adapt and optimise the use of AI to meet the individual needs of learners, thereby promoting truly inclusive education. Indeed, there is evidence to suggest that investing in AI technologies is an important step towards creating more inclusive and welcoming schools.

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