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Exploring the use of a mixed AI and Embodiment Teaching approach to promote self-esteem in primary students

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Abstract: The development of self-esteem is crucial during childhood, as it influences students' emotional well-being, learning abilities and social relationships. This experimental study investigates the effectiveness of a blended teaching methodology that integrates artificial intelligence (AI) with embodiment to promote self-esteem in primary school children. Bracken's TMA, a multidimensional test of self-esteem, was used as a pre- and post-intervention assessment tool. A qualitative analysis based on interviews with teachers was conducted in parallel. The quantitative and qualitative results showed a significant improvement in global self-esteem, particularly in the dimensions related to academic competence, self-efficacy and body image, as well as greater involvement and cooperation among the students, with improved social dynamics in the classroom.

Keywords: Artificial Intelligence, Blended Learning, Embodiment, Self-esteem, Students, Primary School

1. Introduction

Self-esteem is a psycho-pedagogical construct which is central to the process of child development and has a profound impact on multiple aspects of school and social life. According to Bracken (1992), global self-esteem can be divided into several dimensions: academic competence, social competence, physical competence, body image and autonomy. Primary school is a critical period for the development of self-esteem, as children begin to develop a sense of competence and self-efficacy that can influence their future educational trajectories (Harter, 2012).

In his exploratory study, Buccini (2024) analyses how artificial intelligence is changing the educational landscape, highlighting both the opportunities and challenges that this technology presents in the context of teaching and learning. The introduction of artificial intelligence (AI) in schools has opened up new possibilities

for personalising learning and making the educational process more adaptable to the individual needs of students (Holmes et al., 2019). According to Kotsis (2024), artificial intelligence is proving to be a valuable support for teachers in primary schools, facilitating planning. AI can provide immediate feedback and modulate difficulties according to the individual student's abilities, thus increasing the sense of competence and self-efficacy (Luckin et al., 2016). On the other hand, embodiment theory suggests that learning is facilitated when the body is involved in physical activities that promote active interaction with the environment (Wilson, 2002). According to Natalini and Fabio (2023), the idea of an intelligent educational ecosystem is based on the interaction between embodiment and environments, both virtual and real, highlighting the importance of innovative approaches for digital survival in the contemporary educational context.

The aim of this study is to investigate the effectiveness of an educational approach combining AI and embodiment in promoting self-esteem in primary school children through an educational intervention aimed at enhancing perceptions of school competence, body image and self-efficacy. To support this aim, the quantitative analysis was complemented by qualitative research through teacher interviews to explore in more depth the educational and social dynamics created by this teaching approach. The combined results provide a comprehensive picture of the impact of these innovative methods on the development of pupils' self-esteem and the improvement of classroom relationships.

2. Research Structure: Methodology; Participants; Evaluation Tools and Teaching Protocol

The research methodology used was mixed methods, with the quantitative approach covering the 'student' dimension and the qualitative approach covering the 'teacher' dimension. With regard to the quantitative investigation, the study involved 60 students (32 males and 28 females) from a primary school in the city of Caserta (Campania Region, Italy), aged between 8 and 10 years. The students were divided into two groups: an experimental group (n = 30) that participated in the AI-embodied blended learning programme, and a control group (n = 30) that followed the normal school curriculum without the use of AI technologies or embodied activities.

The experimental intervention lasted eight weeks, with two weekly sessions of 60 minutes each. The educational intervention implemented as part of this study involved the combination of artificial intelligence (AI) and embodied practices, creating a learning environment that exploited both the cognitive and physical involvement of the students. The aim was to promote self-esteem and related

dimensions such as academic competence, body image and self-efficacy through integrated activities. The proposed activities were developed on the basis of established theoretical constructs and supported by reference literature.

During the teaching sessions, the students in the experimental group used artificial intelligence-based software designed to provide adaptive learning, modulated in real time according to the students' individual abilities. This form of differentiated learning is rooted in Bandura's (1986) socio-cognitive learning theory, according to which the perception of self-efficacy - the self-confidence to achieve a specific goal - is one of the key elements of academic success. Artificial intelligence, through its ability to provide immediate feedback and adjust the difficulty of exercises based on student responses, creates an environment that enhances perceived self-efficacy, as shown in recent studies (Luckin et al., 2016; Holmes et al., 2019). The software is included:

- Adaptive maths and reading exercises: Through the AI software, students participated in sessions of academic exercises (mathematics and reading) calibrated to their level of proficiency. These exercises were adapted according to the student's performance, implementing the theory of formative feedback (Hattie & Timperley, 2007), according to which immediate feedback enhances learning by providing information about mistakes made and guiding improvement.

- Gradual learning objectives: Students had to complete learning tasks of increasing difficulty, which gradually strengthened their perception of academic competence. This type of progression based on concrete goals follows the principle of self-determination (Ryan & Deci, 2020), according to which the achievement of small personal successes increases intrinsic motivation.The pedagogical aim of this component was to stimulate self-efficacy and school competence, with a focus on building confidence in one's abilities through solving personalised academic tasks, in line with the educational AI literature that highlights the potential of immediate feedback to reinforce learning (Holmes et al., 2019).

- Embodied activities are designed to use the body as a teaching tool, encouraging not only physical interaction with the environment but also cognitive reflection on it. This approach has its theoretical roots in embodied learning theory (Wilson, 2002), which emphasises how the body plays a fundamental role in information processing and knowledge construction. The idea that physical movement can enhance learning while promoting a better perception of body image is supported by several recent studies (Shapiro & Stolz, 2019).

- Maths games with movement: These activities combined mathematical exercises with physical movements. For example, students had to jump over

numbered circles to represent the solution of a mathematical operation. This type of activity is based on the construct of embodied cognitivism (Barsalou, 2008), according to which cognition emerges from the interaction between body and mind. By physically engaging in cognitive problem solving, students strengthened their abstract thinking skills while developing greater body awareness.

- Theatrical reading: Students were invited to physically act out stories or read texts. Through acting, they explored emotions and roles, improving their understanding of texts and their awareness of their own bodily expression. This pedagogical practice reflects the principles of Lakoff and Johnson's (1999) theory of embodied thinking, which suggests that language and abstract thinking are rooted in bodily experience. The bodily interpretation of roles and feelings allowed students to associate emotions and meanings, contributing to improved body image and self-awareness.

- Motor coordination games: Team activities and motor coordination exercises aimed to increase confidence in one's physical abilities, which is central to psychological well-being and the development of a positive body image (Bailey et al., 2009). The exercises promoted cooperative interaction between peers, fostering a sense of belonging and social cohesion, as supported by group cohesion theory (Carron & Brawley, 2000). This element was crucial in promoting both perceptions of physical competence and social autonomy.

These activities had the educational goal of promoting a positive body image and increased confidence in one's physical and motor skills, which are fundamental to the development of balanced self-esteem and in line with what the literature suggests about the importance of integrating the body into educational processes (Shapiro & Stolz, 2019).

A key aspect of the blended learning programme was the personalised feedback provided to the students. The immediate feedback provided by the AI software not only corrected errors but also celebrated successes, positively reinforcing behaviour. Skinner's (1953) theory of positive reinforcement showed that learning is most effective when desired behaviour is rewarded. In our intervention, this was aimed at improving students' intrinsic motivation and confidence in their personal abilities, which helped to increase their perceived self-efficacy and competence in school.

The interaction between AI feedback and embodied activities was a prerequisite for the creation of a holistic educational environment that stimulated both the mind and body of the students. It was hypothesised that this synergy could lead to significant improvements in multiple dimensions of self-esteem, highlighting the

potential of an integrated approach combining innovative technologies and active methodologies, supported by recent educational literature.

Self-esteem was measured using Bracken's (1992) Multidimensional Test of Self-Esteem (TMA), which assesses six main dimensions:

1. Academic competence
2. Social competence
3. Athletic competence
4. Body image
5. Global self-esteem
6. Autonomy

Each dimension was assessed using specific standardised questionnaires in both the pre- and post-test, administered to the students with the assistance of a trained teacher to ensure correct understanding of the questions.

Statistical analysis was performed using two-factor ANOVA to measure the effect of the intervention on the experimental group compared to the control group. Mean scores were calculated for each of the six dimensions of the TMA before and after the intervention. In addition, a Student's t-test was used to compare changes between groups before and after the intervention.

In addition to the quantitative survey based on Bracken's TMA, a qualitative survey was conducted through semi-structured interviews with the teachers involved in the intervention. The aim was to explore the teachers' perceptions of the effectiveness of the blended teaching programme (IA and embodiment) and to gain qualitative insights into the changes observed in the pupils. Ten teachers were interviewed, all with at least 5 years of teaching experience in primary schools.

The interviews followed a guiding line, focusing on four main themes:

1. Perceptions of impact on self-esteem development: Teachers' perceptions of the impact of the programme on pupils' self-esteem, both academically and socio-emotionally.

2. Effectiveness of the combination of AI and embodiment: Teachers' opinions on the combination of AI technologies and embodied activities and their impact on students' learning and engagement.

3. Changes in social and relational dynamics: Observations on how the programme affected group dynamics, peer interactions and collaboration between students.

4. The sustainability and transferability of the intervention: Feedback on how teachers see the feasibility of implementing this approach in the long term and the possibility of applying it to other subjects or contexts.

3. Results

The results of the ANOVA revealed a significant improvement in global self-esteem scores in the experimental group compared to the control group ($F(1,58) = 5.23$, $p < .05$). Specifically, the following improvements were found:

- Academic competence: Average scores in the experimental group increased by 18% over the pre-test ($p < .01$), compared to a 3% increase in the control group, indicating a positive effect of personalised learning via AI. Immediate feedback and adaptive tasks increased students' sense of self-efficacy.

- Global self-esteem: The experimental group showed a 15% increase in post-test scores ($p < .01$), whereas the control group showed a non-significant increase of 2%. This result indicates an overall positive effect of the mixed IA-embodiment approach.

- Body image: The embodied activities produced a 13% increase in body image scores ($p < .05$), indicating greater awareness and acceptance of one's body and physical abilities. The control group showed only a 2% increase.

- Autonomy: A 10% improvement in perceptions of autonomy was observed in the experimental group, suggesting that the integration of AI and embodiment fostered a greater sense of independence in students.

The control group showed no significant changes in the different dimensions of self-esteem, suggesting that the traditional approach did not have a major impact on the students' self-perception during the study period.

Qualitative analysis through content analysis of the teachers' responses then brought to light 4 specific 'themes' which are described below:

1. Perceived impact on self-esteem

All teachers interviewed reported that the programme had a positive impact on students' self-esteem, particularly those who had previously shown insecurity about their academic and social abilities. Teachers indicated that the integration of AI enabled many students to gain confidence through immediate feedback and the achievement of small goals. One teacher explained: Some children who had previously been reluctant to intervene during lessons began to participate more enthusiastically, knowing that they would receive positive feedback for each small improvement. This constant reinforcement led to more active participation and an improvement in perceived competence in school, particularly in maths and reading.

2. Effectiveness of the combination of AI and Embodiment

Most teachers felt that the combination of physical activity and AI technologies encouraged full engagement from students, especially those who tend to be less motivated by purely academic activities. Movement and physical interaction, supported by adaptive AI learning, created a stimulating learning environment that captured the interest of students with different learning styles. One teacher commented, "The physical activities were particularly useful for children who have difficulty sitting still or concentrating in traditional lessons. When they could move and do maths at the same time, they seemed much more engaged. Teachers also noted that the AI tech-

nology made the learning process more inclusive, allowing students with special educational needs to receive the support they needed to progress at their own pace.

3. Changing social and relationship dynamics

Another recurring theme in the interviews was the improvement in social dynamics between pupils. Embodied activities often required collaboration and teamwork, which helped to strengthen bonds between pupils and develop social-emotional skills. I saw children who usually worked alone or had difficulty socialising with their peers become more open and cooperative during group games,' commented one teacher. These changes had a positive impact not only on the self-perception of individual pupils, but also on the social climate of the class as a whole.

4. Intervention sustainability and transferability

Many teachers were positive about the possibility of continuing to use this approach after the end of the study. However, some pointed to the need for ongoing technical support and specific training to ensure that teachers can make the best use of AI tools. I think the programme is great, but it requires a lot of preparation and technological skills that not all teachers have. It should be accompanied by adequate training support,' stressed one teacher. In general, teachers also saw the intervention as applicable to other areas of the curriculum, particularly subjects such as science and languages, where embodied activities can be successfully integrated.

5. Discussion

The quantitative results of this study suggest that the integration of AI and embodiment can be an effective approach to boosting self-esteem in primary school children. The combination of personalised AI-based learning and embodied physical activities was shown to improve not only perceptions of academic competence, but also body image and general self-efficacy.

AI-based adaptive learning showed a significant impact on academic competence, as students received personalised feedback and individualised learning goals. This is in line with recent studies showing that the use of AI technologies can improve academic self-efficacy and engagement (Holmes et al., 2019). Furthermore, the fact that students were constantly challenged to overcome small goals promoted a sense of accomplishment and competence, a key element in the development of a positive self-image (Bandura, 1997).

Embodied activities have contributed significantly to improving body image and body awareness. As supported by embodiment theory (Wilson, 2002), learning is not a purely cognitive process, but involves the body and physical interactions with the environment. Students who participate in positive body experiences tend to develop greater confidence in their motor skills and deeper body awareness, promoting a more positive view of themselves (Shapiro & Stolz, 2019).

The increase in autonomy observed in the experimental group is particularly interesting. This suggests that the use of AI technologies in combination with embodiment not only increases the effectiveness of academic skills, but also stimulates students' sense of independence. This finding can be linked to the recent literature on self-determination, which emphasises the importance of providing students with

opportunities for control and choice in learning processes in order to promote healthy personal growth (Ryan & Deci, 2020).

Furthermore, the findings support the idea that the integration of innovative methods in primary education can have a positive impact on global self-awareness and the building of social-emotional competencies, which are crucial for students' future academic and social success (OECD, 2019).

The interviews with the teachers also revealed a number of key themes that confirm and extend the quantitative findings of the study. The increase in self-esteem perceived by the teachers corresponds with the improvements observed in the TMA scores, particularly for academic competence and body image. This convergence of quantitative and qualitative data supports the effectiveness of the mixed AI and embodiment approach in promoting a sense of accomplishment and confidence in one's abilities.

The effectiveness of combining AI and embodiment, as revealed in the interviews, is reflected in the literature. According to Luckin et al. (2016), AI technologies can dynamically tailor learning, adapting to the individual needs of learners and promoting their cognitive engagement. At the same time, the theory of embodied learning (Wilson, 2002; Shapiro & Stolz, 2019) suggests that movement and physical interaction with the environment enhances learning and motivation, confirming teachers' reports of the effectiveness of physical activities integrated with technologies.

The improvement in social dynamics observed by teachers is also in line with studies showing that embodied activities stimulate collaboration and social skills. According to Carron and Brawley (2000), group activities enhance a sense of belonging and social cohesion, which are fundamental elements in creating a positive learning environment.

Finally, the sustainability of interventions and the need for teacher training is also a prominent theme in the literature on the implementation of AI technologies in education. Holmes et al. (2019) highlight the importance of providing teachers with adequate resources and ongoing training support to ensure the long-term success of innovative programmes based on emerging technologies.

6.Conclusion

This study investigated the effectiveness of a blended teaching methodology that integrates artificial intelligence (AI) and embodiment to enhance self-esteem in primary school students. The results show that the integration of these two components can significantly promote improvements in self-esteem, particularly in the areas of academic competence, body image and autonomy.

Artificial intelligence, with its ability to adjust the level of difficulty in real time and to provide immediate feedback, proved to be an effective tool in promoting academic competence and strengthening students' sense of self-efficacy. Embodiment, through physical activities that involve the body in the learning process, contributed to the improvement of body image and body awareness, crucial elements in the development of healthy self-esteem.

Again, the qualitative survey provided a rich and detailed picture of the educational process, confirming the effectiveness of the IA-ed embodiment approach not only in improving students' self-esteem, but also in fostering collaboration and classroom dynamics.

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The research therefore highlights the importance of a holistic approach to education, where both body and mind are involved in the learning process. In line with recent literature, the findings suggest that the use of advanced technologies such as AI, combined with embodied experiences, can lead to a significant improvement in students' social-emotional well-being, better preparing them for future challenges.

However, further studies are needed to investigate the mechanisms through which AI and embodiment interact in the educational context, and how such approaches can be adapted for students with different learning needs; while from a practical point of view, more preparation and support for teachers is needed to ensure that this educational model is sustainable and applicable on a large scale.

This research provides an important basis for educational innovation, opening up new possibilities for inclusive and personalised education that takes into account not only academic skills, but also the psychological and physical well-being of students.

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