A.T.E.N.A.: ENHANCING CHILD LEARNING THROUGH ARTIFICIAL INTELLIGENCE IN EDUCATIONAL TOOL DESIGN TO BOOST EMOTIONAL INTELLIGENCE

A.T.E.N.A.: MIGLIORARE L'APPRENDIMENTO DEI BAMBINI ATTRAVERSO LUSO DELL'INTELLIGENZA ARTIFICIALE NELLA PROGETTAZIONE DI STRUMENTI EDUCATIVI PER POTENZIARE L'INTELLIGENZA EMOTIVA

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Double Blind Peer Review

Citazione
Lembo, L., Cipollone, E. & Peluso Cassese, F. (2024). A.T.E.N.A.: enhancing child learning through artificial intelligence in educational tool design to boost emotional intelligence. *Italian Journal of Health Education, Sports and Inclusive Didactics*, 8(2), Edizioni Universitarie Romane.

Doi:
https://doi.org/10.32043/gsd.v8i2.1205

gsdjournal.it
ISSN: 2532-3296
ISBN 978-88-7730-493-3

ABSTRACT
The technological evolution that has affected education has sparked growing interest in comparing artificial intelligence (AI) and emotional intelligence (EI) in the educational field. In this context, the A.T.E.N.A. project explores the use of Augmented Reality (AR) as an integration of conventional teaching in a primary school class, analysing how the EI of the child or the class group may be influenced by this methodology. The code used in the project for accessing AR, enhanced by AI, has optimized the learning experience by integrating innovative and interactive elements. Therefore, it aims to demonstrate the need to find a synergistic balance in the development of educational offerings between the importance of the human aspect for conveying the educational relationship and the use of the artificial aspect to optimize teaching.

L'evoluzione tecnologica che ha interessato l'istruzione ha suscitato un crescente interesse per il confronto tra intelligenza artificiale (AI) e intelligenza emotiva (EI) in campo educativo. In questo contesto, il progetto A.T.E.N.A. esplora l'uso della Realtà Aumentata (AR) come integrazione dell'insegnamento convenzionale in una classe di scuola primaria, analizzando come l'IE del bambino o del gruppo classe possa essere influenzata da questa metodologia. Il codice utilizzato nel progetto per l'accesso alla AR, potenziato dall'AI, ha ottimizzato l'esperienza di apprendimento integrando elementi innovativi e interattivi. Pertanto, si mira a dimostrare la necessità di trovare un equilibrio sinergico nello sviluppo di offerte educative tra l'importanza dell'aspetto umano per trasmettere la relazione educativa e l'uso dell'aspetto artificiale per ottimizzare l'insegnamento.

KEYWORDS
Digital Innovation – Primary School– Didactics Tool - Digital Device
Innovazione digitale – Scuola Primaria – Strumento didattico – Strumento digitale

Received 28/05/2024
Accepted 19/06/2024
Published 24/06/2024

Introduction[1]

The growing interest in the role of artificial intelligence (AI) and emotional intelligence (EI) in education has emerged with technological advancements in the educational field. Recent studies have highlighted the potential of both these aspects in enhancing the educational process, although it is important to maintain a balance between them (Chen et al., 2020; Sánchez-Álvarez et al., 2020). AI offers advanced tools to optimize learning efficiency, support teaching planning, teaching methodologies, and enhance educational tools that can be used to support lessons (Ahmad et al., 2021; Lembo et al., 2023; Bakti et al., 2023). Similarly, EI plays a fundamental role in fostering educational relationships, improving the disposition towards and understanding of others, enriching the educational environment, and facilitating the learning process (Puertas Molero et al., 2020). EI is also crucial to ensure that students feel supported, motivated and engaged in the educational process (Cipollone, 2021; Zhoc et al., 2020). The complexity of both dimensions, emotional and artificial, necessitates the integration of both components synergistically to maximize educational benefits. Thus, the combined use of AI and EI can create a comprehensive educational environment aimed at the complete development of students, considering them as complex systems.

The A.T.E.N.A. project (Augmented Tool for Enhancement of Neural Activation) fits into this perspective, confirming the growing importance of integrating technology and teaching (Sudarsana et al., 2019). It provides an initial demonstration of the effectiveness of maintaining a synergistic balance between emotional and artificial potential, believing that using the characteristics of both dimensions gives education, and the training context in general, a better and more complete optimization. The primary goal of the project is to investigate the impact of the combined use of AI in adopting a teaching methodology that integrates AR into teaching materials to enhance learning processes while simultaneously developing students' EI. The code, specifically developed to access AR models, conveyed by QR codes and arUco markers, was integrated thanks to the use of AI, which allowed the creation of AR models that are viewable on tablets, manipulable to improve visualization, and integrable into teaching materials, all to optimize the students' learning experience. This synergy between technology and teaching has introduced interactive and innovative elements that transform the way children interact with teaching material and learn concepts differently from conventional methodology,

[1] Luna Lembo is author of introduction, paragraphs 1, 1.1, 2.1 and 4; Elèna Cipollone is author of paragraphs 2, 3, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6 and conclusion; Francesco Peluso Cassese is research supervisor.

positively impacting learning performance, motivation to learn, and memory components (Lembo et al., 2023; Cipollone et al., 2023).

Previous studies (Lembo et al., 2023; Cipollone et al., 2023) have examined the impacts of AR at various levels. The research started with a needs analysis, which highlighted the challenges students face in understanding highly neuroscientific concepts, such as the neural correlates of linguistic, mnemonic, emotional, and motor processes. In response, the initial research focused on using AR to facilitate the understanding of particularly complex concepts, such as the localization and identification of brain areas. The results showed a significant improvement in understanding and assimilating these specific concepts. Students had access to three-dimensional models representing the topics covered during lessons, allowing them to interact with these models through motor gestures aimed at exploring them (Lembo et al., 2023).

Subsequent research involved students from various university departments, including Education Sciences, Psychology, and Engineering. These studies revealed that the use of AR resulted in significant benefits to student performance and their motivation in studying and learning, both during teacher-facilitated in-person lessons and during individual study at home (Lembo et al., 2023; Cipollone et al., 2023). Finally, the research project investigated how the ability to manipulate stimuli contributed to improving the memorization process (Cipollone et al., 2023).

The AR-based teaching approach proved to be flexible and adaptable, capable of meeting the various attitudes and predispositions of students, regardless of their academic discipline. This methodology takes into account the individual as a result of biological, psychological, and social factors, emphasizing the importance of the learning environment (Kranzler et al., 2020; Giorda et al., 2021; Sannipoli et al., 2020). This innovative approach allows for a broader reassessment of the learning context, enabling students to learn anytime and anywhere, leveraging the support of smartphones with an innovative educational approach.

The adoption of AR-based teaching aims to meet the complex needs of modern students, encouraging more interactive and engaging learning across various university disciplines. The in-depth analysis conducted in this study highlighted the innovative impact of augmented reality on complex visuospatial and semantic memory systems. This research demonstrated that digital technologies not only enhance learning in general but also positively and specifically influence a wide range of cognitive skills, including the acquisition, processing, and memorization of information more effectively and efficiently. In summary, the A.T.E.N.A. project aims to open new perspectives in the field of education, emphasizing the importance of finding a synergistic balance between the human aspect of the

educational relationship and the use of technologies to improve the learning process of digital-native students.

1. AR in Didactics

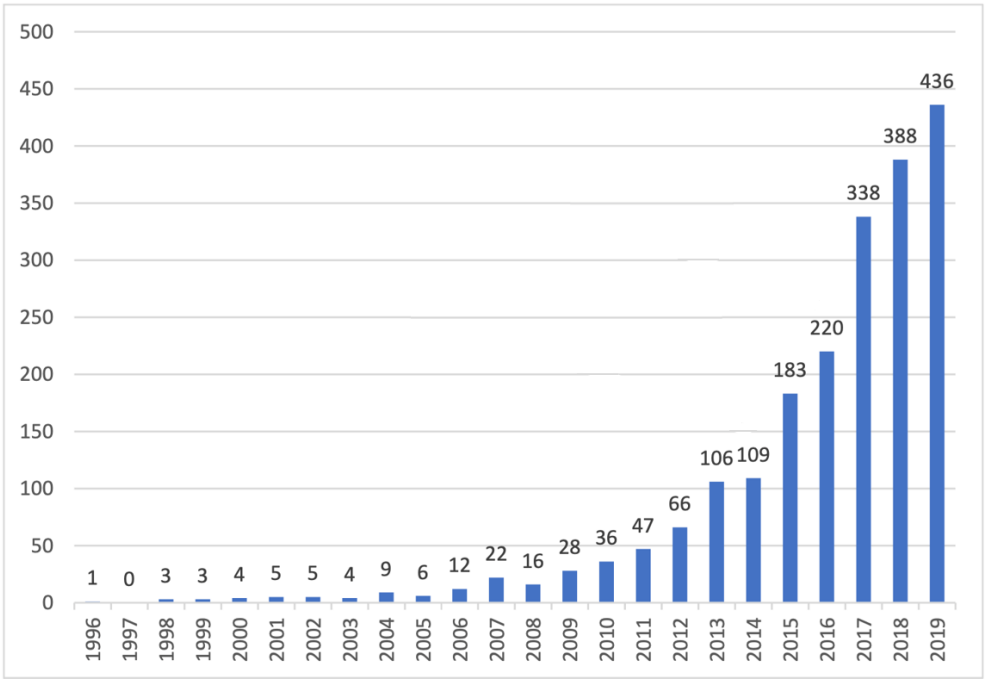


Figure 1 Number of studies of AR in education

The exponential growth of AR studies in the field of education, as shown in Figure 1, reveals a significant trend in the adoption and interest in this educational technology. As highlighted in the figure, there are two noteworthy facts. Firstly, the period between 1996 and 2009 was characterized by a latency phase, during which AR studies in education recorded relatively slow growth. However, 2010 marks a crucial turning point, with a surge in research production in this sector. This corresponds to the advent of mobile AR applications, as predicted by Madden (2011) and confirmed by their global dissemination. This transition to the use of mobile AR has opened up new perspectives in education, making the technology more accessible and versatile (Dey et al., 2018). Mobile AR applications have made it possible to implement interactive and engaging learning experiences, radically transforming the way students interact with educational content. This change has

marked a new era in the adoption of AR in education, making the technology more widespread and accessible to a wide range of users. Additionally, it is interesting to note that this significant increase in AR studies in education occurred concurrently with the development of new platforms and development technologies, such as game engines and SDKs, which have made the creation of AR applications easier and more cost-effective. This has further stimulated interest and adoption of AR in education, enabling an increasing number of institutions and researchers to fully exploit the potential of this innovative technology (Videnovik et al., 2020).

Recent research (Dey et al., 2018; Chen et al., 2019; Garzón, 2021) defines three generations of AR in the field of education. The first generation (1995-2009) is characterized by hardware-based AR, focusing on delivery technology. However, the adoption of AR in education was limited by high costs and reduced usability. Consequently, educational AR applications focused mainly on topics related to health, engineering, and natural sciences, often targeting university students. The second generation (2010-2019) can be defined as application-based AR, as it focused on the development of AR applications rather than AR hardware. The integration of AR into mobile devices significantly increased its popularity in education, making it more accessible and less expensive. As a result, AR applications reached all disciplines and levels of education, emerging as an innovative technology to improve the educational process. However, despite the progress, issues related to accessibility, usability, dissemination, and pedagogical accuracy remain, limiting the impact of AR in education (Bower et al., 2014; Garzón et al., 2019). The third generation (starting from 2020) presents two distinct scenarios: smart glasses and WebAR, enriched by artificial intelligence (AI). Smart glasses, belonging to the wearable technology category, offer significant benefits in inclusive education due to their innovative features (Liu et al., 2017). On the other hand, WebAR offers a pervasive AR experience without the need to download specific applications, making it more accessible and easier to use (Rodrigues et al., 2017). Both of these scenarios, combined with AI, promise to transform AR into a mature, present, and accessible technology capable of enhancing the educational experience. Finally, it should be emphasized that the success of educational AR applications depends not only on technical factors but also on specific pedagogical considerations within the context of use. It is essential to design each application considering the needs, preferences, and predispositions of users in various educational contexts, taking into account their digital nativity.

1.1 AI in Didactics

Recent research (Chen et al., 2020) has demonstrated that artificial intelligence has been successfully employed in various educational institutions, bringing significant improvements in several areas. Among the most relevant applications are the automation of administrative processes and tasks, curriculum and content development, as well as teaching and student learning processes (Chassignol et al., 2018). Artificial intelligence has helped improve efficiency in managing administrative tasks, facilitating the review of student work, assessment, and feedback on assignments through automation via web platforms or dedicated software. Additionally, AI has been successfully employed in curriculum and content development, as well as teaching, leveraging innovative technologies such as virtual reality, web platforms, robotics, video conferencing, audiovisual files, and 3D technology, which have fostered more effective and engaging learning for students (Tahiru, 2021). Thanks to these innovations, teachers have been able to become more effective and efficient (Murphy, 2019), providing students with a personalized and enriched educational experience. Further insights from the analysis of sources indicate that the application of AI in education offers the opportunity to overcome physical barriers related to national and international borders since educational materials are made accessible via the Internet and the World Wide Web. The use of online learning platforms allows students to access materials from anywhere in the world, while the use of language translation tools facilitates more effective learning, tailored to individual student abilities. In summary, the study's results confirm that the use of AI contributes to making administration, teaching, and learning more efficient and effective (Sharma et al., 2019). AI integrated into education allows monitoring of learning progression, including knowledge and understanding, using the results from monitoring to improve the system's ability to adapt content to the needs and abilities of students, in order to work on the level of motivation for learning, leveraging their personal abilities and predispositions to enhance assimilation and memorization (Pokrivcakova et al., 2019). In recent years, AI has made it possible to develop and use intelligent learning systems and personalized adaptive content for the needs and abilities of each individual student, such as intelligent virtual reality and its use in simulated teaching and learning, demonstrating a positive impact on learning (Pokrivcakova et al., 2019). AI allows, through simulated, immersive, and virtual learning contexts, to offer students a practical and experiential learning experience, thus improving the quality of education, information retention, and retrieval, positively impacting academic outcomes (Dignum, 2021).

2. EI in Didactics

In recent years, there has been a noticeable increase in stress, anxiety, and academic difficulties among students, even in the early stages of education (IsHak, Nikravesh, Lederer, Perry, Oguyemi & Bernstein, 2013). This trend can be attributed to several factors, including rising expectations and independence, heavier academic workloads, and a lack of skills in emotional management (Enns, Eldridge, Montgomery & González, 2018). Consequently, EI has gained increasing importance in the field of education as it not only promotes students' psychological well-being but also enhances their understanding of the surrounding world and equips them with essential coping mechanisms to face daily challenges. Therefore, this concept is recognized as an ongoing educational commitment that fosters students' holistic development (Bisquerra, 2009; Petrides, 2016).

EI has become an increasingly important skill for today's students due to the challenges and opportunities present in the modern world. Firstly, we live in an era where interpersonal relationships and communication are essential in almost every aspect of life, both personally and professionally. Being able to understand one's own emotions and those of others, manage conflicts constructively, and communicate empathetically are fundamental skills for building positive relationships and effectively collaborating with others. Additionally, the current world is characterized by a wide range of emotional stimuli and stressors, from academic and social pressures to environmental and global challenges. Having high EI helps students manage stress, anxiety, and other negative emotions in a healthy way, enabling them to maintain mental and emotional balance while facing daily challenges (Quílez-Robres et al., 2023). Moreover, in today's increasingly competitive and dynamic work environment, soft skills, including EI, are highly valued by employers. Organizations seek individuals who can work well in teams, adapt to changes, and maintain a positive attitude even in the face of difficulties. Therefore, developing EI from a young age not only improves students' lives during their school journey but also prepares them for a future of success and personal satisfaction (García-Martínez et al.,2021).

EI is a fundamental aspect that deeply influences individuals' lives, and the school context is no exception. Firstly, it is important to consider that the educational environment is much more than a place where students acquire academic knowledge. It is a social context where relationships are built, challenges are faced, and growth occurs not only intellectually but also emotionally. Therefore, having a good understanding of one's own emotions and those of others is essential for successfully navigating the complex social interactions that characterize school life.

One of the most significant aspects of EI is the ability to manage stress and pressures that inevitably accompany student life. From studying for exams to interpersonal relationships, students must face a series of emotional challenges that can influence their academic performance and overall well-being. Being able to identify and effectively manage one's emotions in stressful situations can make the difference between success and failure (Tirajaya et al., 2024). Additionally, adequate EI e fosters effective communication, a crucial skill for students who need to express their ideas, collaborate with classmates, and interact with teachers. Being able to communicate clearly, empathetically, and assertively can significantly enhance the learning experience and promote a positive and inclusive classroom atmosphere. Another important dimension of EI is self-awareness and self-control. Students who understand their own emotions and can control them are more likely to make thoughtful decisions, adopt effective study strategies, and remain focused on their academic tasks (MacCann et al., 2020).

Consequently, mastering emotional acquisition and utilization is closely linked to academic success, emphasizing the importance of understanding content rather than mere memorization (Dolev and Leshem, 2017; Suberviola, 2012). Therefore, it is imperative to foster the enhancement of students' EI due to its profound impact both academically and socially. In line with this perspective, as stated by Ortiz & Rodríguez (2011), emotional competencies foster cognitive processes and also contribute to concentration and managing stressful situations, while facilitating intrinsic motivation and successful completion of academic tasks (Asle-fattahi & Najarpo Orostadi, 2014; Frederickson, Petrides & Simmonds, 2012).

In conclusion, EI is a fundamental skill that goes beyond mere academic learning and is essential for students' success and well-being both in school and in life. Investing in its development not only improves students' educational experience but also prepares them to face challenges and seize opportunities they will encounter on their journey of personal and professional growth (Pueras Molero et al., 2020).

2.1 Linking Between EI and Cooperative Learning through AR

ATENA responds to the desire to harness the potential arising from the combination of human and digital dimensions. Based on this, it has relied on scientific evidence highlighting the strength of the relationship between cooperative learning and emotional intelligence. Studies conducted over the past decade (Adu et al., 2015; Navarro-Soria et al., 2015; Parveen et al., 2017; Vallet-Bellmunt et al., 2017) have

demonstrated the effectiveness of cooperative learning in promoting not only academic achievement but also students' social and emotional skills. This is because achieving goals through cooperation within a group invariably involves the implementation of EI, which underpins the process and facilitates understanding of others' emotional dimensions, enabling behavioral calibration based on emotional feedback (Torrego-Seijio et al., 2020). By integrating EI and cooperative learning, AR serves as a situational context within which students can experience a learning environment that provides the conditions for balancing the human and digital dimensions. At the same time, it stimulates collaboration among students through and via the implementation of their emotional skills and benefits from the educational contributions derived from the development of AI. Previous studies (Lembo et al., 2023; Cipollone et al., 2023) have shown that AR allows students to immerse themselves in innovative educational contexts that promote active learning and deep understanding of concepts. In this perspective, the potential of the triangular integration derived from the simultaneous use of AR, EI, and Cooperative Learning is envisioned, offering a learning environment that respects the biopsychosocial dimension of the individual. It leverages both the digital predisposition of today's students and the importance of EI in educational processes. This approach, supported by the evidence from the studies of Molina-Luquez & Rodríguez-Estrada (2016), can help enhance social relationships, improve emotion management, and foster students' personal growth. Integrating Augmented Reality into the context of cooperative learning can open new avenues for the education of the future.

3. Research Project

This study is part of a project titled A.T.E.N.A., which aims to respect the digital nativity of students and keep pace with the technological advancements in the educational context by creating a learning environment that integrates digital elements into everyday teaching. In this context, the objective was to harness the potential offered by technology to enhance students' emotional skills. For this reason, we used AI to enhance the code, already employed for generating AR, in order to create an educational environment capable of further boosting EI, a highly sought-after trait in students, through the implementation of cooperative learning.

3.1 Research Hypothesis

The research hypothesis therefore posits that the integration of AR into educational materials and lessons, conducted through cooperative learning, can promote the development of EI components.

3.2 Sample

As a pilot study, we selected a primary school class for the experiment. The sample consisted of 26 children (male=13; female=13) from a third-grade class, aged between 8 and 9 years old.

3.3 Tools

For the assessment of EI, the Trait Emotional Intelligence Questionnaire (TEIQue) was adopted, a self-report tool based on the construct of Trait Emotional Intelligence (Petrides & Furnham, 2000). Trait emotional intelligence, or trait emotional self-efficacy, or trait EI, is the "constellation of self-perceptions located at the lower levels of personality hierarchies" (Petrides, 2011). Considering the age of the sample, the TEIQue-CFS, the short form for children, was used.

This test evaluates individuals' perceptions of their own emotional abilities, specifically how well they can understand and manage their own emotions, those of others, and how they use this information in social relationships. The questionnaire consists of 36 items, rated on a 5-point Likert scale, and is divided into four main dimensions: well-being, self-control, emotionality, and sociability.

To perform the statistical analyses, JAMOVI software (version 2.3.26) was used. Since the experiment involved measuring a variable (EI) at two different times, the paired sample t-test was initially chosen. However, due to the characteristics of the distribution, which was found to be non-normal, the final test employed was the Wilcoxon signed-rank test.

3.4 Methodology

The experiment initially involved the creation of AR educational content related to the subject of history. In a second phase, QR codes and Aruco markers were embedded in the educational materials so that they could be viewed both during lessons and independently during home study. Before proceeding with the start of the experiment, authorization was requested from the school and the teachers to conduct the project during school hours, and informed consent was obtained from each child's parent. During data processing, each child was assigned a code to ensure user anonymity.

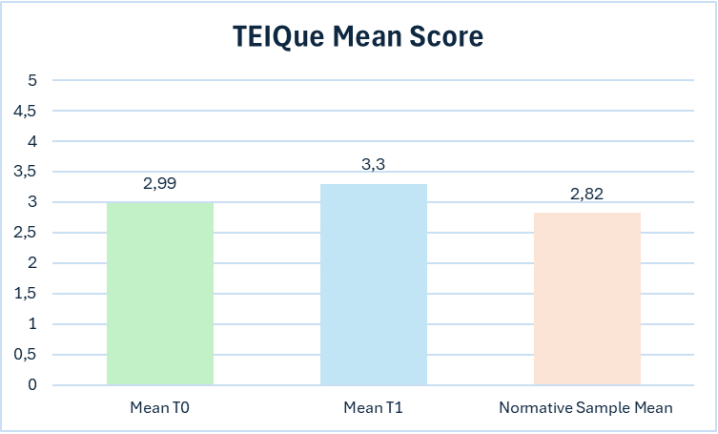
Figure 2. Children using AR during lessons

From November 2023 to April 2024, for two hours a week, the children attended history lessons using AR, which was accessible through tablets provided by the school. The students were taught history lessons within a cooperative learning context. The class was divided into groups of three students each, with each member assuming a specific role that remained the same for the duration of the lesson and changed in the next lesson. The roles involved using the tablet, using the Aruco marker, and using the textbook. Each role was essential for conducting the lesson and equally indispensable for achieving the common goal: learning the proposed educational content. As a result, a climate of collaboration, harmony, and trust among the students was necessary, which allowed the class to develop and demonstrate significant emotional intelligence skills.

The researchers trained the history teacher on how to conduct the educational methodology and were present in the classroom during the experiment to provide technological and technical support. The assessment of EI using the TEIQue-CFS was conducted at T0, in October 2023 before the start of the experiment, and at T1 in May, at the conclusion of the experiment.

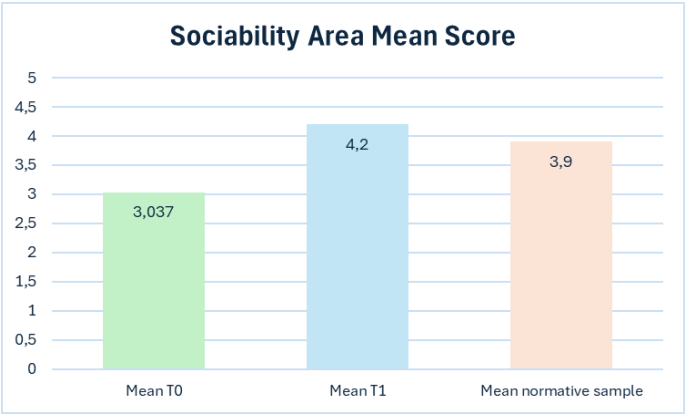
3.5 Results

The following are the results obtained from the administration of the TEIQue-CFS questionnaire.



Graph 1. TEIQue Mean Score

In Graph 1, the average overall results obtained from the sample are reported. As can be seen, there was an improvement in the overall EI score, as the average score increased from 2.99 at T0 to 3.3 at T1. An interesting observation is that the sample exhibits a higher EI score compared to what is typically expected for its age.



Graph 2. Socialibility Area Mean Score

In Graph 2, one of the areas investigated by the TEIQue-CFS, which is more closely linked to the proposed experimental methodology, has been further explored. The sociability factor emphasizes social relationships and influence, focusing on the

individual as an agent in various social contexts rather than personal relationships. High scorers excel in social interaction, communication, and confidence, while low scorers struggle with affecting others' emotions and often appear shy and reserved. As evident from the graph, there was a significant improvement in the Sociability domain, with an increase of 1.2 points, rising from 3.0 at T0 to 4.2 at T1. In this instance, A.T.E.N.A. enhanced this subcomponent to the extent that it exceeded what is typically expected for the age range of the sample.

3.6 Data analysis

Descriptives		
N	T0	26
	T1	26
Missing	T0	0
	T1	0
Mean	T0	2.775
	T1	3.087
Median	T0	2.700
	T1	3.000
Standard deviation	T0	0.468
	T1	0.500
Minimum	T0	2.1
	T1	2.2
Maximum	T0	3.7
	T1	3.9
Shapiro-Wilk W	T0	0.948
	T1	0.951
Shapiro -Wilk p	T0	0.456
	T1	0.499

Table 1. Sample Descriptives

Table 1 displays descriptive statistics for the entire sample (N=26), divided between T0 and T1. T0 mean is 2,775 with 0,468 of standard deviation, while T1 mean is 3,087 with 0,500 of standard deviation. The maximum score achievable on the test was 5, and the maximum score archived was 3.9. The Shapiro-Wilk test detected a significant deviation from normality ($p < 0.05$), suggesting that the data do not follow a normal distribution.

In order to perform the statistical analyses, JAMOVI software (version 2.3.26) was used. Our research hypothesis aimed to analyze the influence of AR usage in didactics on Emotional Intelligence both at the beginning and at the end of the experimentation. Since this was a research design within group, we chose to implement a paired sample t-test. At first, we performed Shapiro Wilk test, in order to verify the assumptions: as showed in table 1, a low p-value suggest a violation of the assumption of normality. For this reason, we used a non-parametric test, the Wilcoxon test.

Paired Samples T-Test						
				Statistic	p value	effect size
A		Wilcoxon W		7.0	0.0202	-0.789

Note. H_a μ *Measure 1 - Measure 2* $\neq 0$

Table 2. Wilcoxon test

As shown in Table 2, the results (W=7.0) indicate a p-value of less than < 0.05, suggesting that the differences observed between T0 and T1 are statistically significant. Additionally, the effect size was evaluated (-0.789), indicating an effect between medium and large.

4. Discussion

ATENA, due to its intrinsic characteristics, addresses the need to integrate both human and digital dimensions within the educational context, respecting the roles, spaces, and timing of both components. At this stage of the project, the aim was to specifically investigate the role of AI in supporting educational design and EI as a result of this integration. Consequently, history lessons were delivered to the research sample in a cooperative learning context, wherein conventional materials were integrated with AR models accessible via tablets. Integrating the use of AR into a cooperative learning context allowed students to define specific roles that were all necessary for the execution of the lesson and thus for the content learning phase. The research hypothesis aimed to explore whether AR integrated into

teaching and provided in a cooperative learning context could improve EI skills, focusing on the sociability subcomponent. In this regard, it should be noted that the research design was based on the Trait Emotional Intelligence theory (Petrides & Furnham, 2000), which refers to an individual's ability to identify, understand, manage, and use emotions effectively and productively. This ability was measured using the Trait Emotional Intelligence Questionnaire (TEIQue), which provides a total EI score and four sub-scores for well-being, self-control, emotionality, and sociability.

The results of the aforementioned test confirm the hypothesis, showing a statistically significant improvement in students, with a p-value of 0.0202. Additionally, from the average results of T0 and T1, it can be noted that there was not only a 0.3 point improvement between the two time points of the experiment, but the sample at T1 also scored 0.5 points higher than expected for their age. Specifically, by choosing to adopt the cooperative learning methodology, the research directly addressed the sociability subcomponent, resulting in an indirect improvement in the total emotional intelligence. The 1.2 point average improvement between T0 and T1 highlights how this component benefited from the chosen methodology. These results are consistent with previous studies (Torrego et al., 2020) that have shown a positive influence of cooperative learning on the components of emotional intelligence: specifically, the literature has highlighted improvements in the subcomponents of adaptability to change (Torrego et al., 2020), self-regulation, and empathy (Tarricone, 2001). This research thus adds another finding regarding the sociability component, understood as the individual's ability to interact socially in various social contexts, rather than personal relationships with family.

This new evidence further supports the integration of emerging technologies, such as AR, in educational contexts to enhance not only academic skills but also socio-emotional competencies, providing a more comprehensive and multidimensional educational approach that addresses the complexity of the individual as a result of the interaction between complex systems. In conclusion, given the small sample size, this research serves as a pilot study that begins to lay the groundwork for outlining an innovative educational methodology that considers not only student development in terms of performance but also the well-being of the individual within the school context, focusing on social skills to foster interpersonal relationships.

5. Conclusions

The study's outcomes hold promising implications for educational practices, emphasizing the potential of AR-enhanced learning environments in nurturing EI among young learners. By leveraging innovative technologies like AR within the educational framework, educators can create dynamic and engaging classrooms that not only facilitate academic learning but also foster crucial socio-emotional skills. The findings underscore the importance of integrating digital tools thoughtfully into pedagogical approaches to maximize their impact on students' holistic development.

The findings of the study underscore significant advancements in EI among primary school students following the implementation of AR integrated into history lessons. Over the course of the experiment, there was a notable enhancement in the overall EI scores from T0 to T1, indicating a tangible improvement in students' emotional competencies, thanks to the use of AI in the implementation of AR code. Particularly striking was the pronounced elevation in the Sociability domain, reflecting a clear positive impact of the experimental methodology.

Additionally, the cooperative learning setting, with students assuming specific roles within groups, fostered a collaborative atmosphere conducive to emotional growth. It is noteworthy that the EI scores surpassed age-related norms, indicating the efficacy of the intervention in surpassing conventional expectations.

Moving forward, further research and exploration of AR applications in education are warranted to continue harnessing its potential in fostering students' socio-emotional development.

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