



ORIGINAL PAPER

Embedding Human Emotional Intelligence in Artificial Intelligence for Educational Benefits

Adrian-Florin Bușu¹⁾

Abstract:

This paper explores the integration of human Emotional Intelligence (EI) into Artificial Intelligence (AI) systems to enhance educational experiences. By embedding EI in AI, artificial systems can understand better and respond more accurately to the emotional states of students, fostering more personalized, empathetic and effective learning environments. Emotional AI can support students' emotional well-being, improve engagement and facilitate tailored learning experiences by recognizing and adapting to emotional cues such as frustration, excitement or stress. Additionally, it enables early identification of emotional or academic challenges, promoting timely interventions. We will examine the potential benefits of Emotional AI in education, including improved teacher-student interactions, enhanced mental health support and more inclusive learning environments. Potential threats such as manipulation or emotional dependency are also tackled in this paper, in order to ensure the responsible use of Emotional AI in educational contexts.

Keywords: *Emotional AI, tailored learning, integration, challenge, benefits*

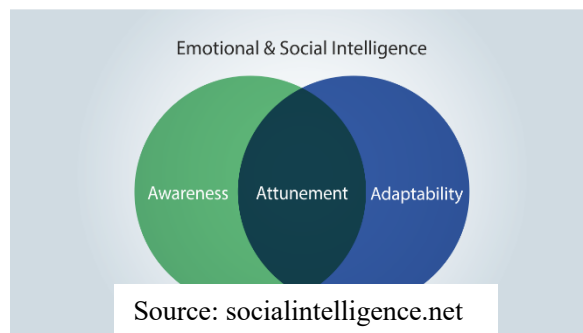
¹⁾ Senior Lecturer, PhD, University of Craiova, Faculty of Letters, Department of Applied Modern Languages, Romania, Phone 0040744177449, email: adibusu2002@yahoo.com. ORCID ID 0000-0003-1379-9918

Introduction

The fusion of Emotional Intelligence (EI) and Artificial Intelligence (AI), commonly known as Emotional AI or Affective Computing, holds transformative potential across various fields, from healthcare and customer service to entertainment and education. Emotional AI seeks to empower machines not only to comprehend human emotions but also to respond in socially and contextually appropriate ways. By integrating EI into AI systems, we can create technologies that facilitate communication and collaboration that closely resemble human emotional interactions. Emotional Intelligence encompasses the ability to perceive, understand, manage and regulate emotions in oneself and others (Dhani & Sharma, 2016; Buşu, 2020). Emotional Intelligence is fundamental to human intelligence, influencing interpersonal relationships, decision-making, empathy and social skills, all of which are essential elements for effective interactions. Traditionally regarded as a hallmark of human cognition, distinct from the logical, problem-solving skills of Artificial Intelligence, Emotional Intelligence's role is gaining renewed focus as we advance AI capabilities. By merging EI with AI, we enhance the richness of human-machine interactions, cultivating empathetic systems that can improve decision-making and foster collaboration, ultimately benefiting society as a whole. This discussion will delve into the core components of EI, explore the challenges of replicating it in machines, review the current landscape of Emotional AI research, highlight promising applications - especially in education - and address potential risks associated with the development of emotionally intelligent machines.

Defining Concepts: Emotional Intelligence, Artificial Intelligence and Emotional AI

1. Emotional Intelligence (EI) represents the capacity to recognize, comprehend and manage one's own emotions while simultaneously discerning and responding appropriately to the emotions of others. The construct integrates two principal components: emotion and intelligence, both of which necessitate precise conceptual delineation. Psychologists have posited various definitions of emotion, yet a widely accepted perspective regards emotions as psycho-physiological responses to environmental stimuli (Gerrig & Zimbardo, 2002: 4). Keltner, Oatley and Jenkins (2013: 27) characterize emotions as “multifaceted responses to events that we perceive as challenges or opportunities in our inner or outer world, events that are important to our goals, particularly our social goals.” Intelligence, conversely, encompasses advanced cognitive functions such as problem-solving, reasoning, learning and comprehension. Intelligence is defined as “the ability to understand complex ideas, adapt effectively to the environment, learn from experience, engage in various forms of reasoning and overcome



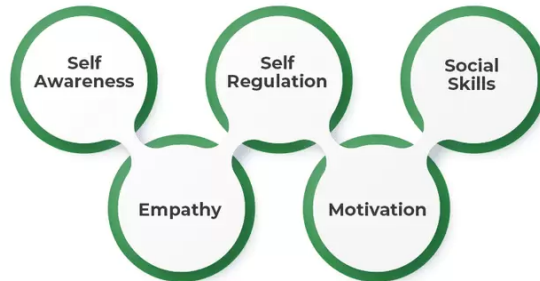
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obstacles through thought.” (Neisser et al., 1996: 1) Empirical research on EI suggests a strong correlation between self-regulation and the capacity to interpret and predict the behaviors of others, highlighting the pivotal role of non-cognitive faculties in human intelligence. EI facilitates the development of interpersonal competencies, fostering more adaptive responses in cognitive and social interactions. Moreover, a profound interconnection exists between Emotional Intelligence (EI) and Social Intelligence (SI). Wechsler (1940: 116) argued that general intelligence encompasses both intellectual and non-intellectual determinants. The latter category includes personality traits that exert a substantial impact on individual success, complementing conventional cognitive abilities. He further asserted that non-intellectual components - comprising both cognitive and affective faculties - exert a formative influence on human behavior, encapsulated under the domain of “social intelligence”. Expanding on this framework, Gardner (1983: 88) distinguished between intrapersonal and interpersonal intelligence, two constructs that emphasize introspection and communicative efficacy, respectively. His notion of “intrapersonal intelligence”, defined as “the ability to utilize, comprehend and regulate one's emotions”, closely parallels the tenets of EI, underscoring the importance of self-analysis in emotional modulation and behavioral adaptation. In summation, EI constitutes an essential dimension of human intelligence, integrating cognitive and affective competencies. Its significance extends to fostering interpersonal efficacy, emotional self-regulation and enhanced adaptability across diverse social and professional contexts.

A critical aspect of the research on Emotional Intelligence is understanding how emotions influence reasoning and whether reasoning about emotions can be considered a form of intelligence (Salovey, Brackett & Mayer, 2004:74). Reflecting on these ideas, Mayer, Salovey and Caruso (2004: 197) updated their definition of Emotional Intelligence, describing it as “the capacity to reason about emotions and of emotions, to enhance thinking. It includes the abilities to accurately perceive emotions, to access and generate emotions to assist thought, to understand emotions and emotional knowledge and to reflectively regulate emotions to promote emotional and intellectual growth”. Consequently, demonstrating appropriate emotions in particular situations requires advanced intellectual skills that allow individuals to analyze, process and evaluate circumstances effectively. Notably, Emotional Intelligence emphasizes the interaction between emotion and intelligence, helping to understand how these two components of human cognition influence one another. Daniel Goleman (1996: 68), a key figure in the popularization of EI, identifies five essential components of Emotional Intelligence:

1. **Self-awareness:** The ability to recognize and understand one's own emotions, thoughts and behaviors, and how they influence others.
2. **Self-regulation:** The ability to manage or redirect disruptive emotions and impulses in healthy ways.
3. **Motivation:** The drive to achieve for the sake of personal fulfillment and goal achievement.
4. **Empathy:** The ability to understand and share the feelings of others, which is essential for effective social interactions.
5. **Social skills:** The capacity to manage relationships and navigate social networks.

EMOTIONAL INTELLIGENCE



Source: <https://dataexpertise.in/advancing-emotional-artificial-intelligence/>

2. Artificial Intelligence (AI)

John McCarthy, one of the pioneers of AI, presented the first definition of Artificial Intelligence at a conference on the campus of Dartmouth in the summer of 1956: *The goal of AI is to develop machines that behave as though they were intelligent.* Since then, scientists and researchers, scholars and theoreticians have struggled to come up with a more complex definition of AI. The result is that nowadays there are so many attempts to define the concept of Artificial Intelligence, that offering a simple and robust answer becomes quite problematic. Basically, AI refers to systems or machines that can perform tasks that typically require human intelligence. These tasks include problem-solving, learning, pattern recognition and decision-making. AI can be broadly classified into two categories:

1. **Narrow AI:** AI systems designed to perform a specific task, such as image recognition, natural language processing (NLP) or playing chess. These systems are highly specialized, but do not possess general intelligence or the ability to understand emotions.
2. **General AI (AGI):** A more advanced form of AI that has the potential to understand and perform any intellectual task that a human can. While AGI is still in its theoretical stage, it is a key goal in AI research, with aspirations of replicating human-like cognitive processes, including emotional understanding.

The concept of Artificial Intelligence has rapidly evolved from a theoretical idea into a tangible, functional reality. Early AI models, primarily based on logical reasoning and rule-based systems, have now given way to more advanced learning algorithms, including machine learning and deep learning, which enable machines to perform complex tasks. However, the development of AI has focused primarily on cognitive abilities, such as processing data, making predictions and solving problems.

3. Emotional AI (Affective Computing)

One critical aspect of human intelligence that has not been fully replicated in machines and which is becoming increasingly vital for the future of AI is Emotional Intelligence. Emotional AI or Affective Computing is an interdisciplinary field that focuses on the development of systems and devices that can recognize, interpret and simulate human emotions (Fleckenstein, 1991: 447). Since the introduction of the concept of Affective Computing (Piccard, 2000), it has been instrumental in enabling computers to recognize and express emotions, as well as respond intelligently to human emotions (Piccard, Vyzas & Healey, 2001). Affective Computing or Emotional AI is a concept that deals with human emotions, feelings, emotion recognition and sentiment analysis. It

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combines insights from psychology, neuroscience, machine learning and computational modeling. Emotional AI is the application of Emotional Intelligence to AI systems, enabling machines to interact with humans in a more empathetic, adaptive and socially-aware manner.

The Challenges of Embedding Emotional Intelligence in Artificial Intelligence

Emotional Intelligence is a fundamental aspect of human cognition; however, embedding it within Artificial Intelligence (AI) systems presents significant challenges. These challenges arise from both the technological limitations of current AI frameworks and the inherent complexity of human emotions (Velagaleti et al., 2024). Several critical difficulties can be identified, some of which require substantial effort to overcome.

One of the primary challenges is the computational modeling of emotions. Human emotions are highly intricate and influenced by a multitude of factors, including past experiences, social contexts and individual personality traits. Capturing this complexity within an AI system requires the development of sophisticated models capable of accurately processing and responding to emotional data. Unlike cognitive tasks, which can often be deconstructed into discrete logical steps, emotions are fluid, subjective and multifaceted. Furthermore, emotional expressions are frequently context-dependent, requiring a nuanced understanding of human psychology, which remains difficult to replicate computationally. Emotional responses also vary significantly across cultural, social and environmental contexts, necessitating AI systems that can adapt to these variations to ensure appropriate and contextually relevant responses.

A second major challenge concerns Natural Language Processing (NLP) and the expression of emotions. Effective Emotional Intelligence involves not only recognizing emotions, but also communicating them appropriately. NLP serves as a foundational technology for enabling AI systems to interact with humans through language (Chowdhary & Chowdhary, 2020). However, existing NLP models primarily focus on analyzing surface-level meaning rather than deciphering underlying emotional tones. While advancements in sentiment analysis have enhanced AI's ability to detect emotions in text, current models still struggle to interpret complex emotional expressions, including sarcasm, humor and subtle linguistic nuances - elements that are essential for effective emotional communication. Moreover, generating emotionally congruent responses remains a significant obstacle, as AI systems must align their outputs with both the explicit and implicit emotional context of a given interaction.

Another critical issue is the interpretation of nonverbal cues, including facial expressions, body language and vocal intonations. Affective Computing has sought to address this challenge by integrating facial recognition and voice analysis technologies in order to enhance AI's ability to interpret human emotions. However, the accuracy and reliability of these systems remain limited. While facial recognition technology can identify basic emotions such as happiness, sadness, anger and surprise, it struggles to detect more nuanced emotional states and complex affective combinations. Additionally, cultural variations in emotional expression present further challenges. For instance, while head-shaking is commonly associated with negation in many cultures, in countries such as Bulgaria, as well as certain regions of Greece, Iran, Lebanon, Turkey and Egypt, the same gesture may indicate agreement. Such variations necessitate AI systems that can adapt to cultural specificities so that misinterpretations are avoided.

Beyond technical limitations, the ethical and moral implications of emotionally intelligent AI warrant critical consideration. The simulation of empathy and other affective responses by AI raises concerns regarding the potential for manipulation. If AI systems are designed to elicit emotional engagement, there is a risk that they could be exploited for deceptive or coercive purposes, particularly in sensitive domains such as healthcare, education and marketing. The distinction between genuine Emotional Intelligence and mere emotional manipulation thus becomes increasingly blurred, necessitating robust ethical frameworks to govern the development and deployment of such technologies.

Whereas the integration of Emotional Intelligence into Artificial Intelligence holds significant promise, it remains a formidable challenge due to the complexity of emotional modeling, the limitations of NLP and nonverbal cue interpretation and the ethical concerns surrounding affective AI. Addressing these challenges will require interdisciplinary collaboration, combining insights from psychology, linguistics, computer science and ethics to develop AI systems that can process and respond to human emotions in a manner that is both accurate and ethically responsible.

Approaches to Embedding Emotional Intelligence in Artificial Intelligence

To address the challenges associated with integrating Emotional Intelligence (EI) into Artificial Intelligence (AI) systems, several approaches have been proposed, leveraging advancements in machine learning, psychology, neuroscience and Affective Computing (Schuller & Schuller, 2018; Vistorte et al., 2024). These approaches aim to enhance AI's ability to recognize, interpret and respond to human emotions in a manner that is both accurate and contextually appropriate.

Affective Computing represents a foundational area of research in this domain, focusing on the development of systems capable of processing emotional information. This interdisciplinary field integrates technologies such as facial recognition, speech analysis and physiological monitoring to detect and interpret emotional states. For example, AI can analyze facial expressions to infer emotions or assess vocal modulation patterns to determine a speaker's affective state. Beyond emotion recognition, Affective Computing also explores the production of contextually appropriate responses. AI systems equipped with such capabilities can, for instance, detect signs of frustration or sadness in a user's voice and respond with empathetic dialogue or supportive actions, thereby simulating human-like emotional engagement.

Another significant approach involves the application of deep learning techniques, particularly convolutional neural networks (CNNs) and recurrent neural networks (RNNs), which have demonstrated efficacy in recognizing complex patterns within emotional data (Vu et al., 2016). These models are trained on extensive datasets of verbal and nonverbal emotional expressions, enabling AI to interpret a broad spectrum of affective cues. Recent advancements in multimodal emotion recognition further enhance AI's emotional understanding by integrating data from multiple sources - such as facial expressions, vocal tone and body language - resulting in a more holistic and contextually nuanced emotional response.

A critical aspect of embedding EI into AI is the simulation of empathy and social skills. One of the primary objectives of emotionally intelligent AI is to replicate empathic behaviors by not only recognizing an individual's emotional state but also responding in a manner that conveys understanding and support. Empathy in AI can be simulated through adaptive dialogue systems, where responses are modulated based on the detected

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emotional context of the user. Additionally, AI can be trained in social skills such as conflict resolution and negotiation by analyzing large-scale social interaction data. Through machine learning algorithms, AI systems can identify patterns in human interactions and generate strategies for managing complex social dynamics, thereby enabling them to navigate sensitive conversations or mediate disputes effectively.

The integration of psychological and neuroscientific principles represents another promising avenue for enhancing AI's emotional intelligence. Insights from psychology, particularly theories of emotional processing, can inform the development of AI models that align more closely with human affective experiences. For example, the Emotional Intelligence framework proposed by Goleman (1996) emphasizes self-awareness, self-regulation and social skills as fundamental components of EI. Incorporating such principles into AI design can provide a theoretical foundation for developing more emotionally responsive systems. Furthermore, advancements in neurofeedback and brain-computer interfaces (Mudgal et al., 2020:56) may enable AI to interact with human emotional states in real-time, fostering more intuitive and adaptive human-computer interactions.

In summary, the integration of Emotional Intelligence into AI requires a multifaceted approach that combines Affective Computing, deep learning techniques, empathy simulation and insights from psychology and neuroscience. While significant progress has been made, further interdisciplinary research is necessary to develop AI systems capable of accurately interpreting and responding to the complexities of human emotions.

Applications of Emotional AI

The integration of Emotional Intelligence into Artificial Intelligence holds immense potential across various industries and fields. Some of the key applications may include:

1. **Healthcare and Therapy:** Emotional AI can play a transformative role in healthcare by providing personalized care and support. AI systems could be used to monitor patients' emotional states and offer appropriate interventions, particularly for individuals with mental health conditions such as depression, anxiety or autism spectrum disorders. AI-powered virtual therapists or chatbots could provide emotional support, making mental health resources more accessible.



Source: demaerre/iStock.com

2. **Customer Service:** Emotional AI has the potential to revolutionize customer service by enabling AI chatbots and virtual assistants to respond empathetically to customer concerns. By recognizing frustration, confusion or anger in a customer's voice or text, AI systems can adjust their tone and responses to create a more positive experience.

3. **Social Companionship:** Emotional AI can also be applied in the creation of social robots and virtual companions (see CompanionAble, EmotiRob or Paro robots). These systems could provide emotional support to elderly individuals, people with disabilities or those living in social isolation. By simulating empathy and understanding, emotionally intelligent AI could help alleviate loneliness and enhance the well-being of vulnerable populations.

4. **Education:** Emotionally intelligent AI could be used to monitor students' emotional engagement and provide tailored support. For example, AI could detect when a student is feeling overwhelmed or disengaged and adjust the learning materials or interaction style to improve motivation and learning outcomes.

Educational Benefits of Emotional AI

The integration of Emotional Artificial Intelligence (EAI) into educational contexts presents significant opportunities for enhancing both the learning experience and broader educational processes (Molero et al., 2020). Key benefits of EAI include providing emotional support, personalizing learning experiences and fostering greater student engagement. A particularly noteworthy advantage of EAI is its capacity to personalize learning by adapting educational content and pedagogical approaches to meet the diverse emotional and cognitive needs of individual students. By detecting emotional cues such as frustration, boredom or enthusiasm, EAI systems can dynamically adjust the pacing, complexity and nature of instructional material, aligning more closely with the student's emotional state and learning preferences.

Another notable benefit of EAI is its potential to increase student engagement. By monitoring emotional signals during lessons or activities, EAI can identify when students disengage or lose focus, prompting the system to employ strategies such as gamification, positive reinforcement or interactive content to regain students' attention and re-engage them in the learning process. Virtual tutors or interactive classroom assistants equipped with empathetic response capabilities can also contribute to a more socially engaging and enjoyable learning environment, cultivating a sense of connection and emotional support. Moreover, EAI may facilitate the development of empathy among students by providing simulated interactions in which they can practice recognizing and responding to emotional cues, thereby enhancing their social and interpersonal competencies.

Additional advantages of EAI in education include the early detection of emotional and learning difficulties. Through the identification of early indicators of emotional distress, learning challenges or mental health concerns, EAI systems can facilitate timely and targeted interventions. Furthermore, EAI holds the potential to enhance teacher-student relationships by fostering a more empathetic and supportive learning environment. Other benefits include improvements in feedback and performance tracking, the facilitation of remote learning, the promotion of mental health awareness, the creation of inclusive educational settings and the encouragement of collaborative learning (Bărbuceanu, 2020).

The application of Emotional AI in education holds significant promise for advancing both the academic and emotional development of students. By fostering a more personalized, empathetic and supportive educational environment, EAI can help students feel more engaged, understood and equipped to achieve their educational objectives. As technological advancements continue, it is likely that Emotional AI will further reshape educational paradigms, making them more responsive to students' emotional and social

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needs while enhancing cognitive outcomes. However, it is imperative that the implementation of Emotional AI is governed by ethical principles, ensuring respect for privacy and safeguarding the irreplaceable human elements that are fundamental to education.

The development of Emotional AI raises profound ethical considerations that must be addressed as the technology advances. A critical ethical issue pertains to the potential for manipulation. Given the ability of AI systems to accurately interpret and respond to human emotions, there is an inherent risk that such systems could be exploited for commercial, political or other unethical purposes (Ienca, 2023:24). To mitigate this risk, it is essential that EAI technologies are designed and deployed with transparency, fairness and accountability. Furthermore, the advent of emotionally intelligent machines introduces concerns related to emotional dependency. If individuals form attachments to AI systems that simulate empathy, there is a risk of over-reliance on technology for emotional support (Zhai, Wibowo, & Li, 2024:10), potentially leading to social isolation and a diminished capacity for authentic human interaction.

Finally, the issue of inequality warrants attention, as Emotional AI, like other AI technologies, may perpetuate existing biases. If the data used to train EAI systems is biased, the systems' emotional recognition and responses may reflect these biases, resulting in inequitable outcomes. To address this challenge, it is extremely important that EAI systems be developed using diverse datasets to minimize bias and promote fairness, ensuring that their deployment fosters equitable and inclusive educational environments.

All things considered...

Embedding human Emotional Intelligence in Artificial Intelligence is an ambitious and complex endeavor that promises to revolutionize the way we interact with machines. By developing AI systems that recognize, understand and respond to emotions, we can create more empathetic, intuitive and effective machines that can enhance human experiences across various domains. However, the journey to creating emotionally intelligent AI is fraught with challenges, including technical limitations, ethical concerns and the complexity of human emotions themselves. Despite these challenges, the ongoing research in affective computing, deep learning and psychological modeling provides promising pathways toward achieving emotionally intelligent AI. As this technology continues to evolve, it is essential that we balance innovation with responsibility. By considering the ethical implications of Emotional AI and ensuring that it is developed with fairness, transparency and respect for human well-being, we can harness its potential to create a future where humans and machines can interact in emotionally intelligent and meaningful ways. The intertwining of Emotional Intelligence and Artificial Intelligence has the potential to profoundly reshape human-AI interactions. By equipping AI systems with the ability to recognize, interpret and respond to human emotions, we might be able to create machines that are not only functional but also empathetic and socially aware. This integration can enhance communication, foster collaboration and provide emotional support across various realms, especially in the domain of education, where it can prove truly beneficial for the progress of students and other learners. By carefully balancing innovation with ethical responsibility, we can ensure that the fusion of Emotional Intelligence and Artificial Intelligence leads to a future where humans and machines work together in harmony to enhance well-being and societal progress.

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