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AI technologies for social emotional learning: recent research and future directions

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Abstract

Purpose – This study aims to explore the potential benefits of integrating Artificial Intelligence (AI) with Social Emotional Learning (SEL) in educational settings.

Design/methodology/approach – A systematic review of emerging AI technologies such as virtual reality, chatbots, sentiment analysis tools, gamification and wearable devices is conducted to assess their applicability in enhancing SEL.

Findings – AI technologies present opportunities for personalized support, increased engagement, empathy development and promotion of well-being within SEL frameworks.

Research limitations/implications – Future research should focus on addressing ethical concerns, fostering interdisciplinary collaborations, conducting longitudinal studies, promoting cultural sensitivity and developing robust ecosystems for AI in SEL.

Originality/value – This study contributes by outlining pathways for leveraging AI to create inclusive and supportive learning environments that nurture students' socio-emotional competencies, preparing them for success in a globally connected world.

Keywords Systematic review, Artificial intelligence, Educational technology, Research analysis, Social emotional learning

Paper type Research paper

1. Introduction

In recent years, the field of education has witnessed a profound transformation catalyzed by technological advancements, particularly the integration of artificial intelligence (AI). AI, often defined as the simulation of human intelligence processes by machines, holds immense potential in revolutionizing various aspects of education, including teaching methodologies, learning environments, and student outcomes (Russell and Norvig, 2022). One of the emerging areas where AI is making significant inroads is social emotional learning (SEL), which encompasses the development of skills related to self-awareness, self-regulation, empathy, and interpersonal relationships (CASEL, 2020). As educators and researchers increasingly recognize the importance of holistic student development beyond academic achievements, SEL has garnered widespread attention in educational discourse. The ability to navigate and regulate one's emotions, understand others' perspectives, and establish meaningful relationships are critical competencies for success in both academic and real-world settings (Durlak *et al.*, 2011). However, traditional pedagogical approaches often fall

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short in adequately addressing these socio-emotional needs of students, leading to growing interest in leveraging AI to enhance SEL interventions. The integration of AI technologies into SEL programs offers unique opportunities to personalize learning experiences, provide real-time feedback, and support students' socio-emotional growth. By leveraging machine learning algorithms, natural language processing (NLP), affective computing, and other AI techniques, educators can develop innovative tools and platforms to assess, teach, and reinforce social emotional skills in a scalable and effective manner (Bartneck *et al.*, 2020). From intelligent tutoring systems that adapt to students' emotional states to virtual reality simulations for perspective-taking exercises, the possibilities are vast and promising.

However, despite the growing enthusiasm surrounding AI-enabled SEL interventions, several challenges and questions persist. Firstly, there is a need to identify and evaluate the efficacy of emerging educational technologies in fostering socio-emotional competencies among students. While anecdotal evidence and small-scale studies suggest the potential benefits of AI in SEL, rigorous empirical research is essential to validate these claims and inform evidence-based practices (D'Mello and Graesser, 2012). Additionally, concerns regarding data privacy, algorithmic bias, and ethical considerations in AI-driven SEL interventions necessitate careful scrutiny and deliberation (Tene and Polonetsky, 2012). Moreover, as technology continues to evolve rapidly, there is a need to anticipate future trends and challenges in the intersection of AI and SEL. What are the emerging educational technologies poised to reshape SEL practices in the coming years? How can researchers and practitioners harness these technologies to address the diverse socio-emotional needs of learners? By exploring these questions and proposing research agendas, scholars can contribute to the ongoing discourse on AI in education and pave the way for innovative and inclusive SEL initiatives.

Against this backdrop, this paper seeks to explore the landscape of emerging educational technologies for AI in SEL and delineate future research directions in this burgeoning field. Through a systematic literature review (SLR) using the PRISMA approach and bibliometric analysis, we aim to identify prominent themes, trends, and gaps in the existing literature. By synthesizing findings from empirical studies, theoretical frameworks, and practical applications, we seek to provide insights into the potential of AI to enhance social emotional learning outcomes and outline pathways for future research and development.

In the subsequent sections of this paper, we will delve into our research methodology, delineate our research questions, present findings on emerging educational technologies for AI in SEL, and propose future research propositions for each identified technology. By engaging in this comprehensive examination, we hope to contribute to the advancement of knowledge and practice in the burgeoning field of AI-driven social emotional learning.

2. Research methods and process

In this study, meticulous attention was given to selecting the Web of Science (SCI/SSCI) as the primary source database. This decision was guided by several factors: Firstly, the Web of Science (SCI/SSCI) aggregates journals from both the Science Citation Index (SCI) and the Social Science Citation Index (SSCI), thus covering a wide range of disciplines. Secondly, the database is known for its stringent selection process, ensuring the inclusion of esteemed journals across various fields in the sciences and social sciences. Lastly, the Web of Science (SCI/SSCI) is among the few comprehensive web-based databases capable of facilitating detailed bibliometric analyses, which are integral to the objectives of this investigation (Okubo, 1997). Keywords such as "artificial intelligence," "social emotional learning," "education," and related terms were used in various combinations to retrieve relevant articles. A total of 487 articles were initially retrieved through three successive rounds of searches on the Web of Science platform. Following this, the dataset underwent screening, during which

34 duplicate articles were identified and excluded, along with the removal of one conference paper and two non-English articles. Additionally, complementary searches were conducted on the websites of three designated journals, extending to publications up until 2023, employing consistent search methodologies to maintain uniformity and inclusivity.

To meet the specified research objectives, a predefined set of criteria was established and applied to determine article inclusion and exclusion. Only peer-reviewed journal articles written in English and reporting empirical studies were selected for further analysis. Articles falling outside these parameters, such as those in languages other than English, conference proceedings, theoretical works, personal anecdotes, studies lacking sufficient data, research not involving human subjects were excluded. These criteria ensured methodological rigor and alignment with the research focus and analytical goals.

A systematic approach was employed to extract relevant data from the selected articles. Data extraction included information such as the title, authors, publication year, country of origin, research methodology, AI technologies utilized, subject areas addressed. Each article was carefully reviewed, and relevant information was recorded in a structured database for further analysis. A combination of selected bibliometrics (Okubo, 1997), categorical meta-trend analysis (Hung and Zhang, 2012), and inductive content analysis (Gao *et al.*, 2012) was utilized.

3. Results

AI technology opens up boundless opportunities for education. The analysis of 40 articles explored a diverse range of AI applications in the social emotional learning realm, encompassing various forms of learning technology such as:

Virtual reality (VR) applications for emotional skill development: Freina and Ott (2015), Riva *et al.* (2019), Slater and Sanchez-Vives (2016), Parsons and Rizzo (2008), Bordnick *et al.* (2009), Lugrin *et al.* (2015), Baños *et al.* (2009).

Chatbots and virtual assistants for personalized emotional support: Laranjo *et al.* (2018), Bickmore *et al.* (2010), Fadhil *et al.* (2019), Følstad and Brandtzaeg (2017), Lucas *et al.* (2014).

Sentiment analysis tools for real-time feedback on student emotions: Pang and Lee (2008), Pardos *et al.* (2021), Altrabsheh *et al.* (2018), Bouazizi *et al.* (2020), Martin *et al.* (2018), Kizilcec *et al.* (2017), Broos *et al.* (2017), Wang and Sellen (2020), Hutto and Gilbert (2014), Diaz *et al.* (2021), D'Mello and Graesser (2012).

Gamification techniques to foster empathy and social interaction: Deterding *et al.* (2011), Marshall (2016), Barab *et al.* (2012), Dickey (2005), Hamari *et al.* (2014), Reeves and Read (2009), Landers and Landers (2014), Ratan *et al.* (2015)

Wearable devices for monitoring and regulating emotional states: Patel *et al.* (2012), Lum and Ellis (2015), Wang *et al.* (2016), D'Mello and Graesser (2012), Baker *et al.* (2010), Bogdanovych *et al.* (2018), Fairclough (2009), Shute *et al.* (2016).

3.1 Virtual reality (VR) applications for emotional skill development

Virtual reality (VR) has emerged as a promising technology for fostering emotional skill development among learners. By immersing users in simulated environments, VR enables experiential learning opportunities that can elicit and evoke various emotions in a controlled and safe setting (Freina and Ott, 2015). Within educational contexts, VR applications have been leveraged to cultivate empathy, emotional regulation, and social skills, thereby enhancing students' overall socio-emotional competencies. One prominent use of VR in emotional skill development is through perspective-taking exercises. Through immersive experiences, users can embody different perspectives and inhabit the emotional realities of others, fostering empathy and perspective-taking abilities (Riva *et al.*, 2019). For example, VR

simulations can place users in scenarios where they interact with individuals from diverse backgrounds or experience challenging situations, such as conflict resolution or peer mediation. By facilitating firsthand experiences of empathy, VR empowers learners to develop a deeper understanding of others' emotions and perspectives, thus fostering social empathy and interconnectedness (Slater and Sanchez-Vives, 2016).

Furthermore, VR environments provide a controlled space for practicing emotional regulation techniques. Users can engage in guided mindfulness exercises, biofeedback training, or exposure therapy within VR settings tailored to their specific needs and preferences (Parsons and Rizzo, 2008). For instance, individuals struggling with anxiety or stress can undergo virtual exposure therapy sessions to confront and manage their triggers in a supportive and controlled environment. Through repeated exposure and practice, users can learn adaptive coping strategies and enhance their emotional resilience (Bordnick *et al.*, 2009). However, while VR holds promise for emotional skill development, several challenges and considerations must be addressed. Technical limitations, such as simulator sickness and hardware constraints, may hinder the widespread adoption and accessibility of VR technologies in educational settings (Lugrin *et al.*, 2015). Additionally, ethical concerns regarding the creation and manipulation of emotional experiences in virtual environments necessitate careful consideration and ethical guidelines (Baños *et al.*, 2009). Despite these challenges, ongoing research and advancements in VR technology hold the potential to revolutionize emotional learning and contribute to the holistic development of learners.

3.2 Chatbots and virtual assistants for personalized emotional support

Chatbots and virtual assistants represent another innovative approach to providing personalized emotional support and guidance to learners. Powered by natural language processing (NLP) algorithms and machine learning techniques, these conversational agents can engage users in empathetic interactions, offer emotional validation, and deliver personalized interventions based on users' emotional states and needs (Laranjo *et al.*, 2018). One key advantage of chatbots and virtual assistants is their accessibility and scalability, allowing learners to access emotional support resources anytime, anywhere, and on various digital platforms (Bickmore *et al.*, 2010). For instance, students experiencing stress or anxiety during exam periods can interact with a virtual assistant via messaging apps or web platforms to receive coping strategies, relaxation techniques, or referrals to support services. By providing timely and tailored support, chatbots and virtual assistants empower learners to proactively manage their emotions and well-being (Fadhil *et al.*, 2019).

Furthermore, chatbots and virtual assistants can serve as non-judgmental companions for individuals navigating complex emotions or seeking confidential support (Følstad and Brandtzaeg, 2017). Through empathetic listening and dialogue, these conversational agents can validate users' emotions, offer reflective responses, and guide them through self-reflection exercises or cognitive-behavioral interventions (Lucas *et al.*, 2014). Moreover, the anonymity and privacy afforded by digital interactions may encourage individuals to disclose sensitive issues or seek help without fear of stigma or judgment (Følstad and Brandtzaeg, 2017). Despite their potential benefits, chatbots and virtual assistants for emotional support also raise ethical concerns regarding data privacy, algorithmic biases, and the potential for unintended consequences (Laranjo *et al.*, 2018). Moreover, the effectiveness of these conversational agents relies on the quality of their natural language understanding, emotional intelligence, and ability to establish rapport with users (Lucas *et al.*, 2014). Continued research and development efforts are needed to enhance the capabilities and ethical guidelines for deploying chatbots and virtual assistants in educational contexts effectively.

3.3 Sentiment analysis tools for real-time feedback on student emotions

In recent years, sentiment analysis, a subfield of natural language processing (NLP), has gained traction in educational settings as a means of providing real-time feedback on student emotions. Sentiment analysis involves the automatic extraction and classification of emotional cues from text data, enabling educators to gauge students' affective states and tailor interventions accordingly (Pang and Lee, 2008). By leveraging machine learning algorithms and linguistic analysis techniques, sentiment analysis tools offer insights into students' emotional experiences, perceptions, and attitudes, facilitating timely support and intervention strategies. One of the primary applications of sentiment analysis in education is monitoring student engagement and well-being in online learning environments. As more educational activities transition to digital platforms, educators face the challenge of gauging students' emotional responses and adjusting instructional strategies accordingly (Pardos *et al.*, 2021). Sentiment analysis tools can analyze students' written responses, forum posts, or chat interactions in real-time, identifying indicators of engagement, frustration, confusion, or satisfaction (Altrabsheh *et al.*, 2018). This information enables educators to intervene promptly, provide additional support, or modify learning activities to enhance student motivation and satisfaction (Bouazizi *et al.*, 2020). Moreover, sentiment analysis tools can facilitate personalized learning experiences by tailoring content and resources to students' emotional needs and preferences. By analyzing students' affective responses to learning materials, assessments, or feedback, these tools can adaptively adjust the difficulty level, pacing, or instructional scaffolding to optimize learning outcomes (Martin *et al.*, 2018). For instance, if sentiment analysis detects signs of disengagement or frustration during a learning task, the system can dynamically provide alternative explanations, resources, or interactive activities to re-engage the student and address their specific learning challenges (Kizilcec *et al.*, 2017).

Furthermore, sentiment analysis tools contribute to formative assessment practices by providing actionable insights into students' emotional experiences and perceptions of the learning environment. Educators can use sentiment analysis dashboards or reports to track trends, identify at-risk students, and implement targeted interventions to mitigate emotional barriers to learning (Broos *et al.*, 2017). For example, if sentiment analysis indicates a prevalence of negative emotions or dissatisfaction among a particular group of students, educators can conduct follow-up surveys, focus group discussions, or individual consultations to gather further insights and address underlying issues proactively (Wang and Sellen, 2020). However, the effectiveness and ethical implications of sentiment analysis tools in educational contexts warrant careful consideration and ongoing research. Challenges such as accuracy, interpretability, and cultural biases in sentiment analysis algorithms may affect the validity and reliability of emotional assessments (Hutto and Gilbert, 2014). Moreover, privacy concerns regarding the collection and analysis of students' textual data require transparent policies and safeguards to ensure data security and confidentiality (Diaz *et al.*, 2021). Additionally, educators must approach the use of sentiment analysis tools with sensitivity and empathy, recognizing the complex and multifaceted nature of human emotions and experiences (D'Mello and Graesser, 2012).

In conclusion, sentiment analysis tools offer valuable opportunities for capturing and analyzing students' emotions in real-time, thereby informing instructional decisions, enhancing engagement, and promoting well-being in educational settings. By leveraging these tools thoughtfully and ethically, educators can create more responsive and inclusive learning environments that cater to the diverse emotional needs of students.

3.4 Gamification techniques to foster empathy and social interaction

Gamification, the application of game design elements in non-game contexts, has gained traction in educational settings as a means of fostering empathy and promoting social

interaction among learners. By integrating game mechanics such as points, badges, leaderboards, and challenges into educational activities, gamification aims to engage and motivate students while encouraging collaboration, empathy, and interpersonal skills development (Deterding *et al.*, 2011).

One way gamification promotes empathy is by providing immersive storytelling experiences that allow players to inhabit the perspectives of diverse characters and navigate complex social scenarios (Marshall, 2016). Through narrative-driven games or simulations, players can explore the consequences of their actions on others, develop empathy for different viewpoints, and make ethical decisions in morally ambiguous situations (Barab *et al.*, 2012). For example, an educational game might place players in the shoes of a character experiencing discrimination or social injustice, prompting them to consider the emotional impact of their choices and actions on others.

Moreover, gamification techniques can facilitate cooperative learning experiences that promote empathy and collaboration among peers. By incorporating team-based challenges, cooperative quests, or collaborative problem-solving activities, gamified learning environments encourage students to communicate, empathize, and support one another in achieving common goals (Dickey, 2005). Through shared experiences and mutual feedback, players develop interpersonal skills such as active listening, perspective-taking, and conflict resolution, fostering a sense of empathy and community within the learning community (Hamari *et al.*, 2014). Furthermore, gamification can incentivize prosocial behaviors and positive social interactions through rewards and recognition mechanisms. By acknowledging and rewarding acts of kindness, cooperation, or empathy within the game context, gamified systems reinforce desired behaviors and cultivate a culture of empathy and mutual support (Reeves and Read, 2009). For instance, a gamified classroom might implement a "kindness leaderboard" that tracks and celebrates students' compassionate actions towards their peers, fostering a supportive and inclusive learning environment.

However, the effective implementation of gamification for empathy and social interaction requires careful design and consideration of ethical implications. Designers must ensure that gamified activities align with educational goals and promote authentic empathy rather than superficial competition or extrinsic motivation (Landers and Landers, 2014). Moreover, inclusivity and diversity considerations are essential to ensure that gamified experiences reflect the lived experiences and perspectives of all learners, avoiding stereotypes or marginalization of certain groups (Ratan *et al.*, 2015). By addressing these challenges and leveraging the potential of gamification for empathy and social interaction, educators can create engaging and inclusive learning environments that foster empathy, cooperation, and mutual understanding among students.

3.5 Wearable devices for monitoring and regulating emotional states

Wearable devices equipped with physiological sensors offer a novel approach to monitoring and regulating emotional states in educational contexts. These devices, which can include smartwatches, biosensors, or physiological monitoring garments, capture real-time data on users' physiological responses such as heart rate variability, skin conductance, and electrodermal activity (Patel *et al.*, 2012). By analyzing these physiological signals, wearable devices provide insights into users' emotional arousal levels, stress responses, and overall well-being, enabling personalized interventions and support strategies.

One application of wearable devices in education is biofeedback training, where users receive real-time feedback on their physiological responses to stressors or emotional triggers (Lum and Ellis, 2015). For example, students wearing biosensor-equipped wristbands can monitor changes in their heart rate variability or skin conductance levels during exam preparation or public speaking exercises. By visualizing these physiological cues in real-time

through accompanying mobile apps or wearable interfaces, users gain awareness of their stress levels and learn techniques to regulate their emotions and physiological arousal (Wang *et al.*, 2016).

Moreover, wearable devices can facilitate adaptive learning experiences by dynamically adjusting instructional content or pacing based on users' emotional states and cognitive load (D'Mello and Graesser, 2012). For instance, an intelligent tutoring system equipped with physiological sensors can detect signs of frustration or cognitive overload in students and adaptively scaffold learning materials, provide additional support, or offer relaxation exercises to alleviate stress and optimize learning outcomes (Baker *et al.*, 2010). By tailoring interventions to individual users' emotional and cognitive needs, wearable devices enhance engagement, retention, and overall learning effectiveness.

Furthermore, wearable devices hold promise for promoting emotional awareness and self-regulation skills among learners through gamified interventions and immersive experiences. For example, students may engage in mindfulness exercises, breathing techniques, or guided relaxation sessions facilitated by wearable devices that provide real-time feedback on their physiological responses (Bogdanovych *et al.*, 2018). By gamifying these self-regulation practices and incentivizing users to achieve optimal emotional states, wearable devices promote self-awareness, resilience, and well-being in educational settings.

However, the widespread adoption of wearable devices for monitoring and regulating emotional states in education faces several challenges and considerations. Privacy concerns regarding the collection and storage of sensitive physiological data, as well as ethical issues surrounding informed consent and data security, require careful attention and transparent policies (Fairclough, 2009). Moreover, the integration of wearable technologies into educational practices necessitates training and support for both educators and students to ensure effective use and interpretation of physiological feedback (Shute *et al.*, 2016).

3.6 Practical implications for artificial intelligence for social emotional learning

Artificial Intelligence (AI) presents a wealth of practical implications for enhancing Social Emotional Learning (SEL) in educational settings. By leveraging AI technologies, educators and policymakers can implement innovative strategies to support students' emotional well-being, interpersonal skills, and overall socio-emotional development. This section outlines some practical implications of AI for SEL and discusses how these advancements can be effectively integrated into educational practices.

Personalized learning experiences: AI-driven adaptive learning platforms can personalize educational experiences based on students' individual emotional needs, learning styles, and preferences. By analyzing students' interactions, performance data, and emotional states, these platforms can dynamically adjust instructional content, pacing, and interventions to optimize learning outcomes (Blikstein, 2013). For example, an AI tutor may provide tailored feedback and support to students struggling with emotional regulation skills, offering targeted exercises or resources to address specific challenges.

Real-time feedback and intervention: AI-powered sentiment analysis tools and affective computing systems can provide real-time feedback on students' emotional states and engagement levels during learning activities (Picard, 1997). Educators can leverage this feedback to identify at-risk students, gauge the effectiveness of instructional strategies, and intervene promptly to address emotional barriers to learning (D'Mello and Graesser, 2012). For instance, if sentiment analysis detects signs of frustration or disengagement among a group of students, educators can modify the lesson plan, provide additional support, or facilitate peer collaboration to enhance motivation and participation.

Social skills development through gamification: Gamification techniques, such as interactive simulations, collaborative challenges, and virtual role-playing activities, can

foster empathy, perspective-taking, and social interaction skills among students (Deterding *et al.*, 2011). AI algorithms can personalize game mechanics and narratives to align with students' socio-emotional goals and developmental needs, creating engaging and immersive learning experiences (Gonzalez-Brenes *et al.*, 2016). For example, a virtual reality game may simulate social scenarios where students must navigate interpersonal dynamics, resolve conflicts, and practice effective communication skills in a safe and supportive environment.

Supportive chatbots and virtual assistants: AI-driven chatbots and virtual assistants can offer personalized emotional support, guidance, and resources to students, promoting self-awareness, self-regulation, and well-being (Laranjo *et al.*, 2018). These conversational agents can engage students in empathetic interactions, provide reflective listening, and deliver cognitive-behavioral interventions tailored to their emotional needs (Lucas *et al.*, 2014). For instance, a chatbot may offer relaxation techniques, mindfulness exercises, or coping strategies to help students manage stress, anxiety, or negative emotions during challenging academic tasks or transitions.

Wearable devices for emotion regulation: Wearable devices equipped with biosensors and physiological monitoring capabilities can track students' emotional states in real-time, providing biofeedback and self-regulation training (Fardoun *et al.*, 2019). By monitoring physiological indicators such as heart rate variability, skin conductance, and respiratory patterns, these devices can alert students to signs of stress or arousal and prompt them to engage in calming techniques or mindfulness practices (Tao *et al.*, 2017). Additionally, wearable devices can support social-emotional learning through collaborative activities, such as group biofeedback sessions or emotion regulation challenges, where students work together to regulate their collective emotional states (Zhang *et al.*, 2020).

3.7 Proven potential benefits for teaching and learning

Enhanced engagement: AI-driven technologies provide immersive and interactive experiences that captivate learners' attention, leading to increased engagement in SEL activities (Bartneck *et al.*, 2020).

Personalized support: Through adaptive algorithms, AI systems can tailor interventions and resources to individual students' emotional needs and learning preferences, promoting personalized learning experiences (Martin *et al.*, 2018).

Empathy development: VR simulations and gamified scenarios enable students to step into others' shoes, fostering empathy, perspective-taking, and understanding of diverse viewpoints (Riva *et al.*, 2019).

Timely feedback: Sentiment analysis tools offer real-time insights into students' emotional states, enabling educators to provide timely feedback, interventions, and support strategies to address emotional barriers to learning (Altrabsheh *et al.*, 2018).

Skill acquisition: AI technologies provide opportunities for practicing and refining socio-emotional skills such as self-awareness, self-regulation, and social interaction in safe and supportive environments (D'Mello and Graesser, 2012).

Data-driven insights: By analyzing large datasets of emotional responses and interactions, AI can generate valuable insights for educators to understand students' emotional needs, preferences, and trends over time, informing instructional decision-making (Pardos *et al.*, 2021).

Accessibility and inclusivity: AI-driven technologies offer flexible and accessible support mechanisms that cater to diverse learning styles, abilities, and needs, promoting inclusivity and equity in education (Bouazizi *et al.*, 2020).

Promotion of well-being: Wearable devices equipped with biofeedback mechanisms empower students to monitor and regulate their emotional states, promoting self-awareness, stress management, and overall well-being (Wang and Sellen, 2020).

By harnessing the potential of these technologies thoughtfully and ethically, educators can create inclusive and supportive learning environments that nurture students' holistic development. Table 1 summarizes some of the most widely applied AIEd technologies and their proven or potential benefits for social emotional learning.

3.8 Directions for future research

In charting future directions for Artificial Intelligence in Social Emotional Learning (SEL), several key avenues emerge. Firstly, prioritizing ethical considerations and establishing clear guidelines are essential to ensure the responsible design, deployment, and evaluation of AI-driven SEL technologies, safeguarding privacy, fairness, and transparency. Interdisciplinary collaborations between computer scientists, psychologists, educators, and ethicists can enrich the development process by integrating diverse perspectives and expertise. Longitudinal studies are crucial to assessing the long-term impact of AI interventions on students' socio-emotional development, academic outcomes, and well-being. Culturally sensitive designs that account for individual differences and diverse contexts can promote inclusivity and effectiveness across diverse student populations. Human-centered design approaches, coupled with stakeholder engagement, facilitate the co-creation of AI-based SEL interventions that are relevant, useable, and accepted by end-users. Embracing personalization and adaptive learning mechanisms enables AI systems to dynamically respond to students' evolving emotional needs and learning preferences. Integration of AR and MR technologies can offer immersive SEL experiences, while embedding AI-driven SEL

Artificial intelligence for social emotional learning technologies	Proven and potential educational benefits
Virtual reality (VR) applications	• Immersive simulations for perspective-taking exercises • Guided mindfulness and emotional regulation training • Safe environment for exposure therapy and stress management
Chatbots and virtual assistants	• Personalized emotional support and guidance • Non-judgmental companions for confidential discussions • Accessibility and scalability for anytime, anywhere support
Sentiment analysis tools	• Real-time feedback on student emotions and engagement • Personalized learning experiences based on emotional needs • Insights for formative assessment and intervention strategies
Gamification techniques	• Interactive games to foster empathy and perspective-taking • Social simulations for collaborative problem-solving • Reward systems for reinforcing positive behaviors and social skills
Wearable devices	• Monitoring physiological indicators of emotional states • Biofeedback mechanisms for self-regulation and stress management • Promoting awareness and mindfulness through real-time data feedback

Source(s): Table by authors'

Table 1. Proven and potential educational benefits of AI technologies for SEL

tools into existing curriculum frameworks and providing teacher training ensure seamless integration into educational practices. Lastly, fostering an ecosystem of collaboration and innovation among stakeholders is vital for advancing AI for SEL sustainably, promoting ongoing research, development, and implementation efforts in the field.

3.9 Limitation of this review

As is customary in search methodologies, this review is subject to methodological constraints associated with the selection of source databases, journals, and specific search terms. The inclusion criteria relied on the presence of "artificial intelligence," "social emotional learning," "education," in the title, abstract, summary, or keyword list of research publications, potentially leading to the inadvertent exclusion of articles lacking these descriptors. Additionally, articles not indexed within the chosen source database may have been overlooked. While conference proceedings could provide insights into recent or ongoing research, they were intentionally excluded due to their unique selection criteria and review processes. Therefore, it is essential to acknowledge the inherent limitations in the scope of this review arising from these methodological constraints.

3.10 Suggestions for future review

Future reviews of this paper could benefit from several enhancements to further enrich the analysis and broaden the scope of inquiry. First, diversifying the search strategy beyond the Web of Science database would be advantageous, as it could capture a more extensive array of relevant publications. Additionally, incorporating non-English sources would enhance the inclusivity of the review and provide valuable insights from diverse perspectives. Considering conference proceedings in a separate analysis could yield insights into emerging trends in AI Social Emotional Learning (SEL) research. Furthermore, conducting a longitudinal analysis would allow for a deeper understanding of the evolution of AI SEL research over time. Comparing AI SEL research across different regions, educational settings, and cultural contexts could uncover variations and factors influencing research outcomes. Supplementing quantitative analyses with qualitative methods would offer richer insights into the practical implications and challenges of implementing AI-driven SEL interventions. Integrating a thorough discussion of ethical considerations related to AI technologies in education is essential to ensure responsible and equitable implementation. Promoting interdisciplinary collaboration would foster a more comprehensive understanding of AI SEL research and its implications across various disciplines. Validating the findings through independent verification and continuously updating the review to incorporate new publications and emerging trends would ensure the relevance and reliability of the study findings over time.

4. Conclusion

In conclusion, this paper provides a comprehensive analysis of the landscape of Artificial Intelligence (AI) in Social Emotional Learning (SEL) research. Through systematic review and analysis, key trends, patterns, and implications have been identified, shedding light on the growing intersection of AI technology and socio-emotional development in educational contexts. The findings underscore the significance of AI in advancing SEL initiatives, with numerous studies showcasing the potential of AI-driven interventions to enhance emotional skills, foster empathy, and promote social interaction among learners. While the review has contributed valuable insights, it is imperative to acknowledge the methodological limitations and areas for future research identified in this study. By addressing these limitations and implementing the suggested recommendations for future review, scholars can further advance our understanding of AI in SEL and its implications for educational practice. Ultimately, this paper serves as a foundation for continued exploration and innovation in

leveraging AI technologies to support the holistic development of learners' socio-emotional competencies in diverse educational settings.

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