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Revolutionizing Autism Education: Harnessing AI for Tailored Skill Development in Social, Emotional, and Independent Learning Domains

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Abstract: This review explores the potential of artificial intelligence (AI) to address the special needs of children with autism. It examines the issues of specific skill development in the course of this review through some features in areas such as Social Skills Training, Emotional Regulation Support, and Independent Learning Skills. This study incorporates input from psychology, education, and technology. Although the article lacks presentation of the original empirical data, it nonetheless synthesizes existing information to provide a comprehensive overview of the current state of the field. The paper firmly recommends the use of individually adapted interventions, leveraging virtual reality, natural language processing, and adaptive learning technologies. This detailed and futuristic approach will help to augment the speed of autism education, via personalizing and enhancing social, emotional, and independent learning for individuals with ASD to address current challenges and ethical considerations. It contributes by proposing AI-driven solutions to improve educational outcomes and promote greater inclusivity and adaptability in autism education.

Keywords: autism spectrum disorder (ASD), independent learning, personalized learning, virtual reality, natural language processing

1. Introduction

Autism spectrum disorder (ASD) is a complex neurodevelopmental condition that involves difficulties in social communication, restricted interests, and repetitive behaviors [1, 2]. In recent years, technology has been integrated into educational interventions to address the unique needs of individuals with ASD [3]. This manuscript, titled "Revolutionizing Autism Education: Harnessing AI for Tailored Skill Development in Social, Emotional, and Independent Learning Domains," aims to explore the potential of artificial intelligence (AI) in transforming autism education.

Children with autism often struggle with social interactions, expressing emotions, and independent learning [4]. Traditional educational approaches, while helpful, may not fully address the diverse needs of this population. The advent of AI provides an innovative opportunity to revolutionize autism education by offering personalized and adaptive interventions that cater to the development requirements of specific skills of each child [5].

There has been an increase in the use of AI in different fields. However, there is still a gap in the literature and practical implementations regarding using AI for autism education. There is an urgent need to address this gap by looking at the potential of AI in three critical areas: social skills training, emotional regulation support, and independent learning skills. This should entail using technology to create personalized educational interventions that address the unique challenges faced by autistic children.

A vast majority of children with autism disorders face social communication difficulties, an occurrence which, in turn, plays a massive role in their life experience [6, 7]. Conventional social skills interventions generally arises as insufficiently effective or personal. Software delivering new functions and features is among the best options to enhance these conventional approaches. One example is AI, such as virtual reality (VR) [8] and natural language processing (NLP) [9]. These systems enable the children to experience real-world social situations and give them a protected environment where they can practice and improve their social interactions thus achieving skill development.

Another important aspect of welfare that must be taken into account in the treatment of the whole person with ASD is emotional well-being [6]. Several children with ASD have trouble making sense of and getting in charge of their emotions, which in turn can lead to an intensified level of anxiety and the like [10]. Scientists

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must examine the possibilities that are as yet unexplored by AI in emotional regulation support for children with autism. The use of AI in providing real-time feedback and assisting through technologies involving emotion recognition like wearable devices [11] would help to a significant extent. Nevertheless, establishing the ethical issues and the risk of privacy loss through the use of these technologies also requires attention.

Intellectual autonomy is of utmost significance in the life of children with ASD. Nevertheless, normal inclusion in educational settings may be inappropriate for the different learning styles and due to consideration of the autistic group [12]. Defend research that investigates the ability of AI to develop independent learning skills and enable the kids to direct their own learning, as this is very important. This can be realized through custom-made learning plans brought fully by the use of AI tutoring systems as well as gamified educational contents. Children with autism can use materials aligning with their unique learning profiles to enhance academic and life skills [13, 14].

Describing the nature of autism and its multi-institutional obstacles, the method followed in this research is an interdisciplinary one. It talks about the psychology, education, and technology to give a whole new level of understanding of potential effect of AI on autism education. This review ensures that the recommendations and outcomes are technologically sound and are, at the same time, pedagogically and psychologically informed for the diverse members of the autism community.

This article thoroughly deals with the transformation of autism along with AI. However, by concentrating on the skill development areas of social skills training, emotional regulation support, and independent learning skills, a new perspective highlighting the role of AI in revolutionizing the existing educational structure for children with ASD. This study exposes researchers, educators, and practitioners to the auspicious opportunities for leveraging AI to produce a more inclusive and effective educational experience for individuals with ASD.

2. Social Skills Training

Children with ASD often face issues with social communication, making it challenging for them to form significant links and engage in reciprocal interactions [15]. Even though conventional interventions for social skills are available, they do not offer the required level of customization to cater to the diverse and nuanced needs of individuals with autism [13]. This section examines the current landscape of social skills training, finds the gaps that exist, and suggests state-of-the-art AI-driven solutions with the potential to revolutionize the way children with autism develop critical social competencies. Table 1 summarizes the key points of each subsection.

2.1. Current challenges in social skills training

Provision of effective social skills training for individuals with autism is faced with diverse complexities like a wide range of ASD characteristics and the intricacy of social interactions [16]. The main issue arises from the strict individual variations present in the ASD community, making diverse teaching methods, communication preferences, and social issues a necessary component. Moreover, the primary difficulty in applying the acquired social skills to unpredicted everyday situations makes the enactment of targeted intervention and constant reinforcement effectively bridging the gap between structured training environments and real-world social interactions [22].

Sensory sensitivities are another challenge since certain social environments could be devastating or uncomfortable for children with autism [17]. Addressing this issue entails integrating sensory-friendly methods in training and creating supportive environments that accommodate various sensory needs. Moreover, understanding and responding to nonverbal social cues like facial expressions and body language is a substantial hurdle [23], requiring clear focus in social skills training programs.

Motivation of kids through facilitating rather than directing should be emphasized as an essential part of the training program, especially in autistic children who have different interests and attention spans. Encouraging interest in employing numerous teaching methods and recognizing individual achievements are some of the best approaches [24]. Successfully achieving peer acceptance and inclusion is also one of the practical problems as it impacts the social settings where learned social skills are practically applied. Educational programs for training are necessary for addressing the methods for creating a friendly environment for neurotypical peers [25].

Lack of financial resources and reluctance towards sending children to specialized social skill programs are the two main

Table 1
Overview of social skills training

Subsection	Summary	Ref
Current Challenges in Social Skills Training	The social skills training for autistic individuals is a broad and complex topic. The factors are empathy for differences, the bigger picture of functional skills, integration of sensory issues or rituals, interpreting unobvious cues, engaging with the interests of the child, achieving friendship with peers, using justice, and the intricate shift from adolescence to adulthood.	[16, 17]
The Potential of AI in Social Skills Training	An AI may also lead to an uprising of social skills thus leading to the independence of people with autism who use the technology ultimately. This might be best illustrated by the ability of people with AI to swap scripts, cause meditation, and in some cases the program can correct mistakes.	[18, 19]
Ethical Considerations in AI-driven Social Skills Training	Implementation of AI in empathy training could lead to several concerns, one of which is collecting data belonging to people without their consent. Snail mail remains the most effective way to avoiding any liabilities related to gaining the content through the consent of the other part and the individual. A major cultural bias in using AI-based technology is its deep-seated tendency to regard human–technological relationships as some kind of means-ends relationship.	[20, 21]

factors [26]. As a result, the new set of guidelines has to be passed to ensure more resources are provided, communities are strengthened, and the programs are made more accessible. Finally, with time, social skill weakness arises as a matter and people need to adapt and develop to those changing social expectations in academic, vocational, and community settings [27]. Finding the way to address these issues, an all-encompassing and individualized method of social skills training that ticks all the boxes is crucial. It has to be the headstone of all interventions, by which individuals with autism can be better on the path of their social development.

2.2. The potential of AI in social skills training

AI can potentially revolutionize social skills training for people with autism. New advanced tools like VR and NLP can produce custom-made learning landscape with high immersion, and dynamic learning environments that suit the needs of individual student [13].

2.2.1. Virtual reality (VR) in social skills training

VR technology is a vital tool to facilitate social skills training for individual with autism. VR can enable kids to practice and enhance their social skills within the safety of controlled environments [28]. This method is used to reduce anxiety level, thus supporting desensitization to social situations. Social skills-related VR activities tailor-made to concrete challenges and aims provide exercises and feedback, activating leads to their success [18]. For instance, if a child finds it difficult to begin a conversation, the VR software will focus on this skill. The very nature of engagement in VR simulations changes the role of users from passive to active contributing factors that incline desire [29].

Over time, VR will be a crucial part of the futuristic social skills-learning systems [30]. It can offer a safe and controlled space for children with autism to practice and generalize their skills in real-life contexts.

2.2.2. NLP in social skills training

NLP is an advanced AI technique suitable for improving social skills training. Individuals with autism usually find it challenging to understand and use language properly in social situations [19]. The algorithms used in NLP can figure out the way a person speaks or writes, give immediate feedback on language use, tone, and context as well as help the researcher in the analysis of data [31].

NLP algorithms can help one to better communicate in social conversations by analyzing conversational behaviors and guiding towards effective communication strategies [32]. For instance, a child who is too formal language or has trouble taking turn in a conversation can be promptly helped by an NLP system. This feedback in real time is really awesome because children get to practice good communication skills and overcome communication problems as they occur in a more personalized way [33].

2.3. Ethical considerations in AI-driven social skills training

The incorporation of AI in social skills training for individuals with autism is a topic that necessitates an exhaustive analysis of the ethical issue. In the first stage of AI application, which is obtaining consent from patients or their guardians on whose behalf to act properly, the role of AI will be to assist in the consent process, not to make decisions on behalf of the patients [34, 35]. The consent process should be performed by means of full disclosure, such as communicating relevant information to the patients about the matter, the way to handle it, and the possible risks that come with AI-based interventions that would allow these data to be stored.

Privacy and confidentiality are vital ethical issues. Strong data security measures must be in place for the protection of sensitive information. Individuals with autism must be assured that their data is securely managed [36]. Cultural competency is another crucial factor. AI interventions maintain cultural sensitivity by respecting diverse cultural norms, values, and communication styles across the ASD community to achieve cultural inclusivity and prevent the imposition of bias or harmful cultural content on individuals with autism [37].

Affordances include importantly considering equal access and fairness. The social skills training using AI must be available to a diverse socioeconomic spectrum. Fairness and reducing disparities and equal access are key to ethical engagement with AI technologies [38]. Transparency and user-friendliness of AI algorithms should be included to allow both the individual with autism, parents, or caretakers to understand the functioning and decisions of the AI system [39]. Transparency supports trust and enable informed decision-making regarding engagement with the AI system.

We argued for human oversight and accountability in maintaining the balance between AI-driven automation and human interpretation of complex social situations [40] to ensure ethical practice is maintained. Division of responsibility for outcomes is important to ensure ethical practice. Lastly, there must be ongoing monitoring and evaluation to periodically assess the effectiveness and the impact of the AI-based intervention [20, 21]. Periodic evaluations can also identify and remedy any unintentional consequences, biases, or shortcomings to ethically refine interventions over time. Placement of these ethical issues will ensure that AI-based social skills training has a clear commitment to responsible practice, inclusivity, and the rights and best interests of individuals with ASD [41].

2.4. Future directions and research implications

As developments in AI linger, it is increasingly reasonable to combine social skills training tools with mainstream education [42]. Nevertheless, further study is essential to refine and validate these interventions. Research programs which are carried out that indicate whether the acquired social skills from the virtual environments (VEs) will be observed in the actual world will provide the bulk of information that will confirm the utility of the AI-based social skills tools [43].

Furthermore, a research must examine the utilization of the selected AI tools, e.g. the combination of VR and NLP, for a more detailed social skills training experience. Comparative studies assessing the effectiveness of AI interventions against traditional approaches will help establish the evidence base for adopting these innovative technologies in autism education.

It is imperative to consider the diverse needs of person with ASD, and inclusive research is paramount to understanding the potential benefits of AI. Both qualitative and methodological research strategies are important for feasible research design and that the needs of a wide range of individuals with ASD are met in the research. As a result, it will be important to consider factors such as age, gender, cultural background, and possible co-occurring conditions in the research on AI-driven social skills training [44]. Consensus between researchers, educators, and developers evidence the development of AI social skills tools that not only address specific challenges related to autism but also adhere to ethically and educationally principled guidelines [45].

3. Emotional Regulation Support

ASD often leads to challenges associated with emotional regulation, which can considerably affect the overall well-being of persons with this neurodevelopmental condition [46]. Emotional challenges such as difficulty recognizing emotions in oneself and others and in expressing feelings correctly can heighten stress levels and deter daily functioning [47]. This section examines the rarely explored aspect of emotional regulation support and explores the potential of AI in offering innovative solutions to address these challenges.

3.1. Understanding emotional regulation in autism

ASD often poses challenges with emotional regulation, which significantly impacts the overall well-being of those with the neurodevelopmental condition [46]. Emotional difficulties, like difficulty identifying their own emotions and others and expressing emotions appropriately, can increase stress levels and impede daily life [47]. This section will explore the lesser-tackled sector of emotional regulation support, discussing the potential for AI to propose novel tools to address these challenges. Emotional regulation support in autistic populations is crucial to its efficacy. Emotional regulation includes recognizing, understanding, and managing emotions and individuals with ASD experience unique obstacles within this domain [47]. One of the most common obstacles is recognizing facial expressions and social cues, which can limit understanding of emotions of others [48]. Expressive challenges, such as difficulty verbalizing emotions or reduced expressiveness in facial expression, can contribute to communication challenges and misinterpretations in social situations. Additionally, sensory sensitivities can evoke emotional responses, leading to being overwhelmed by extreme stimuli [49].

Persons with autism heavily depend on routine and predictability, which are fundamental for emotional regulation. Deviations from established routines can disrupt emotional status and support the need for structured environments and plans to accommodate change [50]. Social skills training and visual supports, like schedules and emotion charts, can promote emotional understanding and expression.

In devices and technology, wearable devices and AI-driven applications are emerging as valuable tools. Wearable devices are able to monitor your physiological metric in real time, offering insight into typical stress or emotional distress patterns that can assist individuals and caregivers in recognizing potential next steps [11]. AI emotion recognition apps encourage interpreting and understanding emotions, largely through visual or auditory cues, which can also improve support for emotional regulation [51].

Addressing emotional regulations in individuals with ASD takes a thorough approach that considers sensory sensitivities, cognitive challenges, and the influence of routine. Tailored interventions, both conventional and technological, can support individuals with autism in managing their emotional lives. The inclusion of AI-driven technologies enhances the available tools and supports a holistic approach to emotional health within the ASD.

3.2. The role of AI in emotional regulation support

AI has a significant impact on the support provided to individuals with ASD who struggle with emotional regulation. AI interventions, such as emotion recognition technology, analyze facial expressions and voice patterns, providing real-time insights into emotional cues and addressing the challenge of interpreting social cues [52, 53]. In addition, AI offers personalized emotional support by providing adaptive feedback and individualized strategies that create a responsive environment tailored to the unique emotional profile of each individual [13]. Wearable devices equipped with AI further contribute to real-time monitoring by analyzing physiological indicators, identifying stress patterns, and facilitating timely interventions [11]. Predictive analytics enhance proactive measures to manage emotional distress [50].

AI-driven interventions in VR create simulated environments for individuals with ASD to practice and enhance emotional regulation skills [43]. These scenarios are customizable, adapting to individual preferences and sensitivities, ensuring a controlled and supportive setting for gradual exposure to emotional stimuli. NLP capabilities of AI support individuals facing expressive challenges [54]. This facilitates verbal expression of emotions, addressing communication difficulties often experienced by those with ASD. Moreover, AI continuously learns and adapts through machine learning algorithms, ensuring that emotional support remains relevant and effective over time [55].

AI offers an all-inclusive toolkit to support emotional regulation within ASD. From recognition of emotions to provision of adaptive feedback, utilizing wearable devices for real-time monitoring, implementing VR interventions, leveraging NLP for communication, and employing continuous learning algorithms, these technologies enable persons with autism to navigate their emotional experiences, fostering a comprehensive and personalized support system.

3.3. Ethical considerations and privacy concerns

The integration of AI in the emotional regulation support, for the people with ASD, is a matter that needs to be carefully balanced as far as ethical and privacy issues are concerned [56]. Informed consent is required of the participants in the research practices, and the autistic people and the caregivers must be given a clear and easily understandable explanation of what AI intervention is, along with the methods (how things will be done) and the possible risks [57]. They should have control over their self-destructive behaviors, yet, the presence of advanced data security systems has to be guaranteed in case medical information about them needs to be kept confidential or unauthorized access can occur.

Ethical concerns are highly related to transparency in the AI system encoding that is to say, the fact that the AI systems do not walk the walk of algorithmic transparency could be an important issue of ethics [58], that is, users might want to know how the system works and they should be given the chance to do so. This will give them the feeling of control and result in respect for their cognitive abilities. It is also important to be sensitive to cultural diversity in order to treat cultural diversity to respect the norms and values of the ASD community [59] and avoid interventions that can be inappropriate or hurtful in certain cultural contexts.

Responsibility to autonomy people and matching them up with the latest technology on emotional regulation that does AI are the other sides of coin in the ethics of users lives [60]. Users should be allowed to make a choice regarding whether they want to join the AI-run emotional regulation system or not. Pulling out the thread of the algorithmic fabric underlying AIML is crucial to removing undeserved responses [61], with the continual identification of problems and improvements leading to the provision of unbiased help for people with autism.

Privacy issues are absolutely imbricated with these ethical standards, pointing out the needs for genuine communication, solid security measures of data handling, multicultural awareness, user

autonomy, and persistent efforts in the direction of bias removal [62]. By focusing on these ethical values, software developers and implementers will manage to create AI interventions that will provide effective emotional regulation support and will respect the rights and privacy of ASD people. Therefore, a model of responsible and inclusive structure is built, which engenders trust and applies AI technologies safely, assisting the autistic community in the process.

3.4. Current limitations and future directions

The use of AI at present to provide emotional healing to the people with ASD does have its own limitations. Despite having high-level technology in emotion recognition, it has a difficulty in deep recognition of the emotional nuances of people with ASD [63]. Wearable devices, which are crucial for on-time monitoring, are mostly problematic when it comes to the comfortable using it, compliance, and sensory overload [11]. The subjective nature of emotional experiences makes it challenging to provide universally effective strategies for emotional regulation. Moreover, the diverse learning profiles within the autism spectrum pose challenges for current AI-driven educational interventions [64], highlighting the need for enhanced personalization.

To address these limitations, future directions in this field aim to incorporate multimodal methods like visual, auditory, and physiological data to enhance emotion recognition accuracy and gain a broad understanding of emotions. Longitudinal studies are essential to evaluate the persistent effectiveness and user satisfaction with AI-driven interventions to provide an understanding of continuous improvement. Incorporating AI with evidence-based educational practices ensures a holistic approach to independent learning skills [65], catering to various learning profiles. Furthermore, prioritizing the user-friendly design in the development process ensures technologically advanced interventions and responsive to the needs of the different autism spectrum. Continuous efforts to monitor and address biases in AI algorithms and the development of adaptable VR interventions further contribute to a more inclusive, effective, and personalized future for persons within the autism spectrum.

4. Independent Learning Skills

Encouraging the development of independent learning skills is critical for the academic and lifelong success of persons within the autism spectrum [66]. The one-size-fits-all method of traditional education may not address different learning styles and preferences within the autistic population. Therefore, innovative methods are essential in promoting autonomy and self-advocacy. This section investigates the overlooked area of independent learning skills and studies the potential of AI in transforming educational practices for persons within the autism spectrum.

4.1. Understanding independent learning in autism

Understanding independent learning in autism entails identifying the specific challenges and strengths of persons within the autism spectrum. Independent learning entails initiating, managing, and completing learning tasks independently [67], an essential skill for academic success and lifetime learning. Cognitive and sensory differences are crucial, with executive functions like planning and organization posing challenges and heightened sensory sensitivities that can impact the ability to independently structure and execute learning tasks [68].

Learning preferences and styles in individuals with ASD typically involve visual thinking and a preference for routine and structure [69]. Special interests, which are intense and focused, can be leveraged to enhance motivation and engagement in independent learning. Communication difficulties, both expressive and receptive, may require tailored strategies, with AI-powered communication tools proving invaluable in supporting effective expression and comprehension [70].

Executive function and planning are vital to independent learning and benefit from task breakdowns and time management support [71]. AI systems can help create step-by-step guides and give reminders or timers. Encouraging self-advocacy is integral to independent learning. AI-powered tools foster communication and decision-making [72], enabling persons within the autism spectrum to express their needs and make informed choices.

If we take the core of the issue, learning independence in ASD relies on a deep knowledge of various sensory, cognitive, and social dimensions that are pertinent to ASD. It is a process that is guided by an in-depth appreciation of the uniqueness of every individual, which enriches the empowerment of teachers, family members, and creators to become cocreators of the learning process [73]. As a result of this cooperative effort, autistic individuals are fostered to be able to develop learning skills by themselves and focus on their particular strengths, thus promoting independence and lifelong learning.

4.2. The role of AI in fostering independent learning

AI has the potential to help persons within the autism spectrum overcome challenges in independent learning. AI can provide customized support that aligns with the preferences and abilities of learners using adaptive learning technologies, personalized learning plans, and gamified educational content [74]. Since independent learning skills involve several domains, AI interventions can be designed to address several needs. AI can help in independent learning for persons within autism spectrum three ways: personalized learning plans, AI-driven tutoring systems, and gamified educational content [74, 75].

AI-generated personalized learning plans substantial enhancement of the individualized learning needs of learners within autism the spectrum [76]. These plans are established by analyzing the cognitive strengths, preferences, and challenges of learners. They give a roadmap for educational content delivery by adapting the pace of learning materials, format, and content. AI ensures that persons within the autism spectrum can engage with the curriculum in a manner that optimizes their learning experience [5]. As AI-powered plans are dynamic [77], they advance based on current evaluations and feedback. For instance, if a learner excels in a subject, the AI system can regulate the complexity of the material to ensure a continuous challenge that aligns with the capabilities of individuals.

AI-driven tutoring systems provide real time, adaptive support to persons within the autism spectrum as they navigate several educational tasks [13]. These systems employ machine learning algorithms to evaluate the progress of the learners, identify areas of difficulty, and offer targeted assistance. The interactive nature of AI-driven tutoring systems enables immediate feedback [78], facilitating a supportive and responsive learning environment. NLP capabilities can improve these tutoring systems by fostering communication and comprehension. Persons within the autism spectrum who could face receptive and expressive language skills challenges can benefit from AI systems that adapt to their unique communication styles [35], which makes the learning process more accessible and appealing.

Gamification is an auspicious method that can engage persons within the autism spectrum in independent learning activities

[75]. AI-driven, gamified educational content transforms learning into a pleasant and motivating experience by integrating game-like elements like rewards, challenges, and interactive simulations. The inherent structure of games gives clear goals, immediate feedback, and a sense of achievement, which particularly benefit persons within the autism spectrum who flourish in routine and structured environments [79]. AI algorithms can design the difficulty levels and pacing of game-based educational content, to ensure an optimal balance between challenge and success [74].

4.3. Ethical considerations and inclusivity

Ethical imperatives and inclusivity are crucial during the implementation of AI in interventions for persons within the autism spectrum. These principles ensure the responsible use of technology while protecting the rights and health of persons with ASD [80]. Maintaining privacy and data security is essential. There should be strong measures in protecting sensitive personal data, with transparent data usage, storage, and protection policies. Obtaining informed consent is equally vital to respect the autonomy of persons within the autism spectrum and their right to choose their level of engagement with AI-driven interventions [81].

Cultural competence is essential to inclusivity, acknowledging and accommodating various cultural norms, values, and communication styles with ASD [82]. Technologies should be designed considering accessibility, adopting universal design principles to address unpredictable abilities and preferences. Collaboration and codesign concerning persons within the autism spectrum, caregivers, and educators in the development process improve inclusivity by prioritizing end-users perspectives and needs [13].

Preventing bias in AI algorithms is an essential ethical consideration. Regular evaluation and audits are vital to identify and correct biases to ensure fair and reasonable outcomes [61]. Over time, continuous monitoring and adaptation of interventions are critical in addressing emerging ethical concerns and upholding effectiveness [20, 21]. Socioeconomic discrepancies must be recognized, and efforts should be made to address these gaps in access to AI-driven interventions. This includes considerations of availability, affordability, and support for persons within the autism spectrum across various economic backgrounds.

Ethical considerations and inclusivity are essential during the integration of AI into interventions for persons within the autism spectrum. By keeping the values of the privacy principles, informed consent, cultural competence, accessibility, collaboration, bias alleviation, continuous monitoring, and addressing socioeconomic discrepancies, AI-driven interventions can contribute to a more inclusive, respectful, and effective tools to support persons with ASD.

4.4. Current limitations and future directions

The identification and understanding of the present limitations of current AI interventions for people with autism and the steps that will need to be taken in the future are very important for the building of such an ecosystem that would be more supportive. All presenting emotion recognition technology has the feature of missing some information, especially in capturing the fine-grained and subtle emotions that individuals with autism might exhibit [83]. Wearable devices provide real-time monitoring but face practical challenges regarding user comfort and adherence, necessitating ongoing refinement for enhanced usability [11].

Another drawback is the subjective nature of emotional experiences, highlighting the need for personalized methods in emotional regulation interventions [84]. Likewise, the various learning profiles within ASD pose a challenge for ongoing AI-driven educational interventions, instigating a call for improved personalization in tutoring systems, learning plans, and gamified educational content [3].

Future directions include integrating multimodal methods, visual, auditory, and physiological data to improve the accuracy of emotion recognition. We recommended longitudinal studies to evaluate the persistent effectiveness and user satisfaction with AI-driven interventions, offering valuable insights for current refinement. Incorporating AI with evidence-based educational practices is proposed to ensure an all-inclusive and holistic method for developing independent learning skills [85]. We highlighted user-friendly design principles encompassing persons within the autism spectrum in the co-design process to create interventions that are technologically advanced and responsive to the various needs and preferences within ASD.

Addressing current constraints and channeling efforts toward multimodal methods, longitudinal studies, evidence-based integration, and user-centered design can advance AI interventions for ASD toward more effective, inclusive, and personalized support systems for persons with ASD.

5. Future Research Directions and Open Issues

Referring to the potential of AI-guided therapies for the treatment of social abilities in ASD [86], the impact of the sector is developing very quickly. However, as reported in a recent publication [56, 86], it is absolutely necessary to face the existing challenges and find future research issues that are going to make the interventions more effective and, at the same time, more inclusive. In the text, we mention some crucial aspects of the future and the issues that are unresolved.

5.1. Enhancing personalization and adaptability

The forthcoming research in AI social skills training for ASD should mainly be directed to the work on algorithms that grow and transform with a need of the person [56]. This demand to build very complex models that can learn and adapt themselves while they interact, adhere to user preferences, and follow up the progress that remains the same over time [86]. The programs that are tailored to the forces of individual that everyone can search their own pace; different domains are being covered including language, coding, and robotics. The major concerns are the development of AI systems that are effective in capturing and reducing these chameleon needs and the continuous level of metrics to evaluate and modify the personalization in real time [87]. Through the greater emphasis on personalization and adaptability, AI interventions can offer more effective personal support, thus improving outcomes for individuals with ASD. The primary focus on personalization ensures that the interventions retain their utility and produce the desired effect as people mature and their demands adjust.

5.2. Bridging the generalization gap

Research in the next few years should strive to maximize the transferability of social skills that people with ASD learn in strictly controlled environments to situations that exist in our world for them. The construction of AI tools that mimic different social scenes

and contexts can be an essential factor for people to apply their abilities in everyday situations [86]. One of the main concerns is related to coming up with approaches to AI that can accurately mimic the intricacies and unpredictability of the real social life and assess their effectiveness of cross-transferring [88]. More of the found strategies could incorporate different places and situations that change dynamically into the teaching of a variety of contexts, thus, meeting the requirements of the very social interaction. Bridging the distance between experimental environments and practical application in the real world is bound to tackle the issue of impractical use of social skills obtained via AI interventions and, thus, to enhance the well-being of people with ASD by virtue of being more independent and integrated in the society.

5.3. Addressing sensory sensitivities

The autism community wants to identify the method involved in the AI-powered social skills training so that sensory sensitivities can be accommodated better. People with ASD in this form of social skills training are often very sensitive and, therefore, need special ways to teach that are technologically supported [89]. One of the options is personalizing sensory operations. The perfect situation is when a learning situation is easily adaptable with a multitude of stimuli like lights, sounds, textures, thus allowing the user to choose their unique flavors whether they are sensitive or not. This user-designed system is an answer to the problem of sensory discomfort as well as the potential building of the knowledge and the skills of the persons involved in the training [90].

Still, there are barrios that researchers need to cross to overcome this. One necessary step is to find out the most successful means to include these sensorial features as well as to get solid data and measurements of their effect in learning [91]. Empowering those participants with ASD who are fully engaged in the act of learning to rise is a whooping success [92]. By including such a feature as sensory accessibility, AI interventions in ASD will gain power to provide a more helpful and responsive mode of training. Which in turn will nurture the varying needs which are people with ASD [91]. This variant of the tactic can make the training more comfortable but at the same time will avoid that the sensory conflicts, which usually occur, will spoil the acquisition of the leading social abilities.

5.4. Ethical AI and bias mitigation

One typical research field is the codification of ethical principles and the use of strategies to eliminate biases in AI-driven social skills training of the ASD for some time in the future [93]. AI is the one which must be open for the good of the universe. A robot should act as transparent and explicit as it can uphold the rights of people, data privacy, and the reputation [94]. The biggest challenge is to make algorithms used in AI accessible, not only to the users with ASD but also to their caregivers and also establishing the regular audits for identifying and eradicating any biases before they even become an issue [95].

Through the pathway to transparency, the developers develop a trustworthy relationship and encourage individuals with ASD and their caregivers to select these AI technologies themselves in an informed manner [93]. It is non-negotiable to address bias if we want to make social skill support be effective for all people with ASD irrespective of their background or unique features [95]. For the sake of this ethical consideration, which is critical to creating the right AI systems that help people develop their social skills and at the same time are transparent and equal, it is important to make sure that these systems are possible only through the social revolution of technology [94]. In the long run, these activities will be compassionately improved, and social justice will be maximally achieved for the ASD community [93].

5.5. Longitudinal studies and real-world implementation

One of the research objectives is for future research to be directed towards the making of robust programs in the form of longitudinal studies requiring efficiency, satisfaction, and user longevity of AI-based social skills therapies for people with ASD [96]. These studies are necessary to determine the strength of the interventions over time and to what extent these interventions induce powerful effects. Successively, foremost aspect is to bring changes into practice which is of highest priority. It means investigating how AI interventions can be used in the real world as in educational institutions and other facilities where the ASD population is mostly to interact with [97].

The most important problems to address are designing sound methodologies for long-term impact and creating plans for AI interventions integration into the educational and support community systems [98]. Scientists continuously sustain the applicability of the interventions in the real environment with existence as well. This persistence closely matches the experience of the owners, thus researchers may gradually introduce interventions, stop, or modify them to accommodate the duration of the users' lifetime.

By following this approach, we guarantee that AI-based social skills training is and will remain relevant and effective no matter at what stages of our lives it adopted. To the utmost, these endeavors will play a significant part in the social development and improved quality of life for individuals with ASD [96].

5.6. Multimodal data integration

Possibilities for success in scientific research are the integration of data by providing environmental cues, quality of music stimuli, and achieving health monitoring information through the use of AI-based social skill training for children with ASD [99]. This batch of data sources that are disparate from each other can also result in making a big stride over accuracy and sensibilities in AI interventions [100].

Issues are foremost the challenging tasks of devising methods that are superior for combining and analyzing data and concurrently retaining data safety and privacy [101].

Among the improvement of a multimodal data type in AI, the system can get a general profile of user interactions and responses, thus, the process is more personalized and effective [100]. On the other hand, privacy-related issues have become a hot topic. Involving user trust entails the storage of personal data safely through robust data security systems [102].

In the long run, the prime objective of this amalgamation is to come up with superior AI systems that can assimilate and answer the various requirements of individuals with ASD. This will, in turn, results in better social skills development and allow for the development of AI technology that has a genuine impact on ASD individuals [100].

5.7. Collaboration with stakeholders

The key focus of future research in AI-driven social skills training in individuals with ASD will lay in the first place to prioritize the collaboration with a broad set of stakeholders including

the ASD persons themselves, their families, educators, and clinicians [103, 104]. Involving the stakeholders at the different phases of the project is key to the development of feasible and field-friendly viable interventions [105].

The demanding challenges are the establishment of effective feedback loops to ensure the meaningful involvement of the viewpoints of all stakeholders, including the facilitation of learning and research stages [104]. Via enabling impacted individuals to contribute insights directly through engagement, researchers and developers empower the AI tools to be more reactive to real society needs and more practically useful [105]. This approach results in the spawning of products and services that can address the specific problems and choices of individuals with ASD, therefore, compelling them to totally embrace and clearly prove their functionality. In addition, the constant interaction with the participants brings out the most sophistication of the technique, making it adaptable and correspond to the lifestyles of people with autism. It is a win-win situation for everyone [105].

The recruited pairing strategy intensifies the general effect of AI-driven social skills training systems and at the same time acts as a notable advantage for their successful use in the real world.

6. Conclusion

Providing a comprehensive review the manuscript illustrates the impacts of AI on the future of people with autism. It presents the idea of social skills training, emotional regulation support, and independent learning skills as the most needed for the children with autism spectrum, and in facts, through such an approach, the book spells out the unique functions that AI has to help address the many problems of people with ASD.

Joining AI with social skills training is indicated as the latest technique that uses the technologies like VR and NLP for the creation of 3D and fully personalized interventions. In emotional regulation support, AI does this by supplying emotion recognition technology, wearable devices, and personalized emotional support strategies. The use of AI in recognizing and responding to the personal emotional profiles of persons within the autism spectrum can be compared to the invention of a new technology that will forever solve emotional problems.

The study of independent learning skills has demonstrated the adaptability of AI technologies to the varying learning profiles among learners in the autism spectrum. Personalized learning plans, AI-driven tutoring systems, and gamified educational content back up the three jobs. The article highlighted the unanimous requirement of handling the ethical aspects and keeping in mind the morals in the design and application of AI technologies so that they are effaced and do not violate the rights and needs of the sufferers.

The implementation of AI into autism education is of its own complex nature as well as challenges in this field. Promising AI technologies need to be developed and evidence of such work is already present in the related research and meetings of persons with autism, educators, and technology developers. These works are essential for their enhancing privacy regulations and positive user experience, and the technologies will be successful only if they are reliable and can be trusted.

This review invites the autism education and AI communities to work together through continuous improvement and learning. Endeavoring considerable autonomy and with the cover of a general approach and a responsible strategy, the future of AI can gain insight into people directly. The upbringing of autistic children may become more gratifying, as they will be in their proximity showing their superior way. The nonverbal expressions that facilitate dialogue will be typical in their interactions. Hence, they will make a happy family.

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Ethical Statement

This study does not contain any studies with human or animal subjects performed by any of the authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

Author Contribution Statement

Oyeyemi Patricia Adako: Conceptualization, Investigation, Writing – original draft. **Oluwafemi Clement Adeusi:** Software, Investigation, Resources, Writing – original draft. **Peter Adeniyi Alaba:** Methodology, Resources, Writing – review & editing, Supervision, Project administration.

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