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From Stable to STEM and STEAM: Integrating Equine-Assisted Therapy, ICT and Innovative Educational Approaches for ASD

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Abstract

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder with a wide range of symptoms affecting social communication, interaction, and behavior. Recently, the increase in the number of children diagnosed with autism has challenged the scientific community and schoolteachers to seek out new and effective educational and therapeutic strategies for autistic individuals. Besides conventional therapies, alternative and complementary therapies are becoming more and more a part of special education. Equine-assisted therapy or therapeutic riding is one such non-conventional therapy, which falls under the broader category of animal-assisted therapies. Therapeutic riding features a carefully designed therapeutic interaction of the client with the horse, combining physical exercise of the horse's movement, emotional involvement, and social exchanging which, through providing multisensory experiences, can lead to the development of communication skills, emotional regulation, and social engagement in autistic children. Meanwhile, the swift progress of digital technologies and creative pedagogical methods has not only opened doors for inclusive education but also paved the way for the role of Information and Communication Technologies (ICT), STEM and STEAM learning models, which are being progressively incorporated in schools to give a boost to creativity, problem-solving abilities, and interdisciplinary learning experiences among students with different educational needs. This research delves into the theoretical foundation of ASD and plays out how equine-assisted therapy can work as a complementary intervention for autistic children. It also discusses the possible merging of therapeutic riding with digital technologies and STEM/STEAM educational models that lead to the creation of innovative and acting frameworks capable of supporting autistic children in inclusive educational settings.

Keywords: ASD; Equine-Assisted Therapy; Therapeutic Riding; ICT in Education; STEM Education; STEAM Education; Special Education; Inclusive Education

1. Introduction

Autism Spectrum Disorder (ASD) is a challenging neurodevelopmental disorder that includes the core symptoms of social communication and interaction difficulties, along with restricted, repetitive patterns of behavior, interests, or activities (American Psychiatric Association, 2013; Lord et al., 2020). The idea of the autism spectrum serves to illustrate the great variations of symptom presentation and severity in different individuals, and thus the very different developmental profiles and support necessities of children who have been diagnosed with ASD (Volkmar & McPartland, 2014; Lai et al., 2014; American Psychiatric Association, 2013; Lord et al., 2020).

One of the most significant aspects of greater autism awareness is that the concept of a "spectrum" has given rise to the recognition that autism can manifest itself in very different ways and severities. In fact, the aim of the new definition

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was to capture the wide-ranging expression of autism in the general population that can be anything from a very mild condition which hardly affects the individual's life to a profoundly disabling disorder.

Since autism prevalence has risen considerably over the last decades at a global level, autism-related research has also expanded particularly in the areas of understanding its causes, enhancement of diagnostic methods, and the search for more effective interventions (Pergantis&Drigas, 2024; Pergantis et al., 2025; Moraiti et al., 2022). It is well established that Autism is a multifactorial disorder affected by genes, brain and environmental factors together that determine the way brain develops and functions (Casanova, 2007; Courchesne et al., 2007; Geschwind, 2011). Several neurobiological researches have pointed out that the brains of people with autism typically work differently in terms of connectivity, sensory processing, and information integration, and such differences can have an impact on social cognition, emotional regulation, and communication processes (Baron-Cohen et al., 2009; Pelphrey et al., 2011; (Casanova, 2007; Courchesne et al., 2007; Geschwind, 2011; Pelphrey et al., 2011).

Social interaction and communication skills of children with ASD are the areas in which they face the most serious difficulties. Quite often they have very little or no eye contact, they are not only poor in reading other people's emotions and gestures, but also are not able to convey their own message to others in a socially accepted manner, while their language skill can be quite late which results in their use of communication for social purposes being very limited. Further, repetitive behaviors, a need to stick to routines, and an obsession with specific activities or objects are considered core symptoms of ASD (American Psychiatric Association, 2013; Volkmar & Wiesner, 2009). These types of developmental features may cause children to participate less in school and social situations, thus stressing the need for early and effective intervention programs (Dawson & Watling, 2000; Rogers & Vismara, 2008).

Implementing educational and therapeutic interventions for children with autism is usually a multi-disciplinary process which can make use of behavioral, educational, and therapeutic strategies. Behavioral methods, specialized teaching programs, speech-language therapy, occupational therapy, and individualized education plans are some of the means most commonly used to help support communication, socialize interaction and general functioning in everyday life (Dawson & Watling, 2000; Schreibman et al., 2015; Sandbank et al., 2020). The goal of these intervention programs is to improve the developmental trajectory and increase opportunities for social inclusion of individuals with ASD.

At the same time, these days less conventional choices in interventions are being discussed more and more within the arena of special education and developmental psychology. Among these less conventional methods, animal-assisted interventions have been identified as a successful way of increasing emotional engagement, motivation, and social interaction in people with developmental disorders (O'Haire, 2013; Fine, 2019). People can or do benefit in a lot of different ways from their interaction with animals which include, but are not limited to psychological well-being, emotional growth, and social participation.

Equine-assisted therapy or hippotherapy is a particular type of animal-assisted therapy in which the intervention is based on the deliberate interaction with horses under the supervision of trained professionals (DePauw, 1986; Gabriels et al., 2012). Riding horses for therapy usually means riding on horseback activities, grooming horses and guided interactions with horses, which gives the patient a wide range of stimuli through the senses as well as a physical work that may be helpful for motor skills, coordination, and balance (Sterba, 2007).

Numerous research studies have indicated the possibility of equine-assisted therapy to have quite substantial therapeutic effects for individuals with ASD. Children with autism who have been involved in equine therapy, showed social functioning improvements, communication skills, emotional regulation, and behavioral organization (Bass, Duchowny, & Llabre, 2009; Gabriels et al., 2015; O'Haire, 2017). The steady, rhythmic movement of the horse, plus the emotional connection the child develops with the animal, are likely to be the factors that facilitate a therapeutic setting which supports the child's engagement, motivation, and social interaction.

At the same time, today's classrooms often include the use of digital technologies and innovative teaching methods to provide inclusive educational experiences. Information and Communication Technologies (ICTs) have been acknowledged as highly effective means for accessibility improvement, communication, and tailored or individualized learning of students who have special educational needs (Al-Azawei et al., 2016; Parsons & Cobb, 2011). Various digital tools such as communication applications, visual schedules, educational software, and virtual learning environments have been regularly used to aid the development of communication, social skills, and independent learning in students with ASD (Fletcher-Watson, 2014; Grynszpan et al., 2014).

Moreover, educational models that combine interdisciplinary fields e.g., STEM (Science, Technology, Engineering, and Mathematics) and STEAM (Science, Technology, Engineering, Arts, and Mathematics) education have recently been to

the forefront of educational research worldwide. These two models focus on enhancing problem-solving, creativity, critical thinking, and social skills through collaborative learning activities that combine different fields of knowledge for solving real-world problems (Yakman& Lee, 2012; Honey et al., 2014). Thus, STEM and STEAM environments in the case of children with ASD can be considered as avenues for structured exploration, hands-on learning, and technology engagement that influence both cognitive and social development (Bers, 2018).

In fact, in this scenario, the fusion of equine-assisted therapy, digital technologies, and STEM/STEAM educational principles is a new area of research. This unique combination has the potential to open up new avenues for the creation of innovative educational and therapeutic environments that cater to the comprehensive development of children with ASD.Therefore, the goal of this paper is to study ASD theoretically and to discuss the role of equine-assisted therapy as a complementary intervention for children with ASD. Also, the paper looks at how Information and Communication Technologies and STEM/STEAM educational approaches can contribute to forming multidisciplinary frameworks that support inclusive education and foster innovative intervention practices for children with autism.

1.1. Research Questions

The present study aims to explore the potential integration of equine-assisted therapy with digital technologies and STEM/STEAM educational approaches in supporting students with ASD. In order to address this aim, the following research questions were formulated:

- RQ1.

How can equine-assisted therapy contribute to the social, emotional, and behavioral development of students with ASD?

- RQ2.

What role can Information and Communication Technologies (ICT) play in supporting educational interventions for students with ASD?

- RQ3.

How can STEM and STEAM educational approaches enhance learning experiences and participation for students with autism in inclusive educational environments?

- RQ4.

What are the perceptions of educators and professionals regarding the integration of equine-assisted therapy, ICT, and STEM/STEAM approaches in autism intervention programs?

RQ5. To what extent can a multidisciplinary framework combining therapeutic riding, digital technologies, and STEM/STEAM education support innovative intervention strategies for students with ASD?

2. Methodology

The current research employs a method of literature review to examine how equine-assisted therapy, ICT, and STEM/STEAM educational approaches can be effectively combined to support students with ASD.Literature reviews are mainly employed in research on education and social sciences to summarize what is known, to trace the development of research, and to point out areas in the scientific literature that are under-researched (Creswell, 2018; Cohen et al., 2018). By collectively inspecting and dissecting previous research, literature reviews enable researchers to create theoretical bases and to offer extensive explanations of multifaceted cross-disciplinary topics.

This study reviewed academic literature relevant to four major themes:

- ASD and its educational characteristics
- equine-assisted therapy and therapeutic riding interventions
- the use of Information and Communication Technologies (ICT) in special education
- STEM and STEAM educational approaches in inclusive learning environments.

Academic peer-reviewed journal papers, books, and conference proceedings were primarily collected and studied to understand the main theoretical perspectives and empirical results on these topics. Special attention was paid to research that investigates new intervention methods for students with ASD.

The literature was systematically checked for recurring and emerging themes and research directions. The reviewed literature mainly includes studies published during the last two decades, focusing on the intersection between special education, digital technologies, and innovative therapeutic interventions for ASD.

3. ASD: Characteristics and Educational Needs

3.1. ASD: Definition and Core Characteristics

ASD is a neurodevelopmental disorder affecting communication, social interaction, behavior, and sensory processing. Per the DSM-5, ASD is defined by persistent difficulties in social communication and interaction in various settings, together with restricted and repetitive patterns of behavior, interests, or activities (American Psychiatric Association, 2013). The autism spectrum refers to the considerable variation in the type and intensity of symptoms exhibited by the individuals diagnosed with this disorder (Volkmar & Wiesner, 2009; Lord et al., 2018; Simos & Karabatzaki, 2025).

ASD usually makes its presence felt at a very early stage, interrupting the normal developmental pathways of the affected individuals during their lifetime. Symptom manifestation is often more evident within the first couple of years when communication or social contact impairments are observed. Among the earliest signs are lessened eye contact, a lower response level to social stimuli, problems with joint attention, and language development delays (Tager-Flusberg, Paul, & Lord, 2005).

Besides difficulties with communication and social skills, people with autism often engage in restricted and repetitive pattern of behaviors. Such behaviors can include repeated motor actions, a change-resistance, ritualism, hyper-focus on one or more subjects/objects (American Psychiatric Association, 2013; Volkmar & McPartland, 2014). The presence of such types of behavior can be viewed as a reaction to the need to create stability and predictability in the face of an environment which is perceived to be overwhelming.

In the case of ASD, one of the main differences found between people with the disorder and those without is in the way sensory processing takes place. It is a well-recognized fact that many children with autism react unusually to sensory input, whether it is sound, light, texture, or movement that is, they may show either an exaggerated or diminished response (Ben-Sasson et al., 2009; Baranek, 2002). Sensory differences may be one of the major factors influencing emotional regulation, behavior, and participation in day-to-day as well as educational activities.

3.2. Communication and Social Interaction Difficulties

Communication and social interaction difficulties are a hallmark of ASD. Autism can manifest in many ways; for example, some autistic children may not acquire language or they may use language in smaller fragments or in very different ways. Sometimes a person with autism has little or no verbal communication while in other cases the person may develop language and yet be challenged in the use of language for communication ways like pragmatic skill initiations, maintaining conversations, or the understanding of figurative language and social conventions (Paul, 2008; Lord et al., 2018).

Social interaction difficulties and communication deficits go hand in hand. People with ASD have trouble reading and understanding non-verbal communication such as facial expressions or gestures and tone of voice (Baron-Cohen et al., 2009). That is why they have a hard time figuring out what the social situation is, what people are feeling or intending and how to respond appropriately (Drigas et al. 2016&2021; Chaidi & Drigas, 2022; Bamicha & Drigas, 2022, Politi-Georgousi S et al.2020). These kinds of problems are a factor as to why people with autism find it hard to make and keep friends. It may be that a child with ASD spends time by himself and will not be with their peers and show little interest in playing or social engagement. At school, such challenges might lead to reduced participation in group activities, collaborative learning, and classroom communication (Volkmar & Wiesner, 2009).

Besides communication and social interaction difficulties, ASD is characterized by differences in emotional regulation and social reciprocity. People with autism may have trouble recognizing and expressing emotions and that may reflect on their effectiveness in social interactions (Baron-Cohen et al., 2009). Thus, school settings that are structured and intervention strategies that are target-oriented are usually necessary to support social communication development and emotional understanding.

3.3. Educational Interventions and Support Strategies for Autism

Early intervention is now considered a crucial factor in bringing about positive developmental outcomes in children with ASD. Several studies have documented that participation in early and intensive intervention programs may considerably improve communication, social interaction, and adaptive functioning of individuals with autism (Dawson & Watling, 2000; Rogers & Vismara, 2008; Simos , 2026a).

Many intervention models have been developed for helping children with ASD both in education and therapy. Among them, the ones that are most broadly used in practice is Applied Behavior Analysis (ABA) which is a behavioral treatment that attempts to identify desirable behaviors that need reinforcement and relearning of those behaviors which interrupt learning or socializing (Schreibman et al., 2015). The majority of ABA-based programs are located in early intervention and participants have demonstrated improvement not only in communication, cognitive development, and adaptive functioning but also in relationships.

Besides this approach, a popular one which is a TEACCH (Treatment and Education of Autistic and Communication-Handicapped Children) method that gives priority to structured teaching and arranging or organizing the environment of the learner support the cognitive and behavioral features of people with autism. (Mesibov& Shea, 2010) Teaching with the structure includes, for example, visual schedule, usage of learning spaces that is well organized and instruction on an individual basis.Another very popular communication method used to educate the skills of communication in children who have autism, with very limited verbal communication is the Picture Exchange Communication System (PECS). PECS is a method that allows communication in non-verbal individuals through the use of visual symbols and has been documented to positively impact the development of language and functional communication (Bondy & Frost, 2001).

Last but not least, complementing structured school-based procedures, other therapeutic interventions are gaining popularity among those who have autism (Simos, 2025a). At present, these interventions consist of a variety of therapies such as sensory integration, play-based, art therapy, and music therapy which are directed at promoting emotional expression, social engagement, and cognitive development in individuals with autism (Fine, 2019; O'Haire, 2013).Equally important to this group of interventions are animal-assisted interventions which have shown to be a major promising supplementary approach for individuals with developmental disorders. The emotional engagement, motivation, social interaction, and interaction with the animals giving a suitable therapeutic environment that encourages participation and learning (O'Haire, 2013). Among these, the attention of many has been drawn by the combination of physical movement, sensory stimulation, and emotional interaction in equine-assisted therapy.

4. Equine-Assisted Therapy and Therapeutic Riding as Autism Interventions

4.1. Animal-Assisted Interventions and Therapeutic Riding

Animal-assisted interventions, or AAIs, are one of the innovations with significant ramifications for the changes in the therapy landscape. Developmental and psycho-pathological patients are the main subjects of these innovative therapeutic methods. It has been established that a controlled interaction between animals and human beings has the potential to lead to positive psychological effects, greater social interaction, and emotional well-being of individuals (Fine, 2019; O'Haire, 2013).

As one of the animal-assisted intervention types, equine-assisted therapy stands out due to the unique characteristics of the horse-human interaction. Equine-assisted therapies have various contemporary notions such as therapeutic riding or hippotherapy. They are regularly considered as one of the ways of interaction being physical activities accompanied by the horse riding sessions, grooming, and directed contact with the horse, all of which are done under the supervision of professionals (DePauw, 1986; Stebra, 2007).

Typically, a therapeutic riding program is administered by a multidisciplinary team such as a therapist, educator, psychologist working with the support of a trained riding instructor. Through experiential activities and movement based work with the horse, this kind of program aims to develop participant's physical, emotional, cognition, and social aspects (Sterba, 2007).Horses interaction offers a wide range of physiological and psychological benefits. While the physical stimulation of balance, postural control, and motor coordination are delivered by rhythmic movement of a rider's horse, the motivation, self-confidence, and trust can be aroused through the emotional bonding to the animal (Gabriels et al., 2012).

4.2. Benefits of Equine-Assisted Therapy for Individuals with Autism

To date, equine-assisted therapy has drawn attention as a compatible mode of treatment in the case of ASD. Therapeutic riding, according to studies, can advance different development areas, such as social interaction communication, emotional regulation, and behavioral control (Bass, Duchowny, & Llabre, 2009; Gabriels et al., 2015).

Therapeutic riding activities, if a good proportion of them is made, can potentially lead to social interaction and communication of children with autism. Besides, grandstanding the horses involves many different ways through which the individuals can learn and communicate with instructors, resort to peers, etc. These experiences that may boost the communication abilities of the individual and socializing skills in the framework of a structured and multitasked environment (O'Haire, 2017).

Besides promoting social and emotional competences, the contribution of equine assisted therapy to the physical domain is evident. The horse-generated movement stimulates continuous sensory-motor provision with resulting gains in balance, posture, and motor coordination. Such physical adaptations might be particularly significant for children with autism who encounter difficulties with motor planning or who have unusual sensory processing (Sterba, 2007).

4.3. Therapeutic and Educational Dimensions of Equine-Assisted Programs

Equine-assisted therapy, when properly orchestrated by experts, combines both therapeutic and educational aspects. People with autism can be supported by these structured interventions through physical fitness exercises and sensory interaction with horses alongside social participation and engagements (Gabriels et al., 2012).

Typically, therapeutic riding consists of numerous main elements, including mounted and unmounted riding, directed riding sessions, horse care, and interaction tasks aimed at developing communication and teamwork skills. These experiences are the vehicle through which participants hone motor functions, cultivate emotional sensitivity, and enhance their sociability all within a secure and supportive setting.

On the other hand, from an educational standpoint, the benefits of therapeutic riding are substantial. Interactions with horses offer a learning environment packed with problem-solving, accountability, and the carrying out of set tasks. Such scenarios foster the growth of a sense of independence and self-efficacy among individuals with ASD (O'Haire, 2013).

Furthermore, the constantly changing nature of the equine-assisted therapy suits modern pedagogical methods that focus on learning through experience and sensory engagement. These methods may be particularly effective for students with autism who typically show a good response to environments that are well structured and which make use of movement, visual cues, and hands-on activities.

In view of all these arguments, equine-assisted therapy has gradually become a well-deserved recognition as a very useful complementary intervention that can work synergistically with traditional educational and therapeutic programs for individuals with ASD.

5. ICT and Digital Technologies in Autism Education

5.1. The Role of ICT in Special Education

In recent years, Information and Communication Technologies (ICT) have become increasingly essential for educators working in special education (Simos & Xyloparkioti, 2025). Digital tools can meaningfully support inclusion by enabling flexible, personalised, and interactive learning environments that cater to students with diverse educational needs (Al-Azawei, Serenelli, & Lundqvist, 2016; Bondarenko et al., 2023; Bardis et al., 2023).For students with ASD in particular, ICT offers considerable advantages; from encouraging interaction and communication to providing more structured learning pathways and motivating participation in a range of classroom activities (Boucenna et al., 2014; Aresti-Bartolome & Garcia-Zapirain, 2014). Digital platforms and assistive technologies also equip teachers with the means to design tailored learning experiences that account for the cognitive, behavioural, and sensory characteristics commonly associated with autism (Grynszpan et al., 2017; Karadimas & Drigas, 2017).In practice, these technologies facilitate the creation of visual supports, the sequencing of learning into manageable steps, and the development of interactive settings that can strengthen focus and engagement among students with ASD (Konstantinidis et al., 2009; López-Díaz et al., 2024). Such tools are particularly well suited to learners who respond strongly to visual information and who tend to thrive in well-ordered, predictable learning environments (Knight et al., 2016).

5.2. Digital Tools Supporting Students with Autism

Today, a wide variety of tools are available which are specifically designed to support students with ASD not only during class hours but also during therapy sessions (Aresti-Bartolome & Garcia-Zapirain, 2014; Syriopoulou-Delli &Gkiolnta, 2022). These include, among others, communication applications, visual schedule apps, educational computer games, and web platforms that promote learning through interaction (Boucenna et al., 2014; Konstantinidis et al., 2009).One of the most widely used types of technology for enhancing communication among individuals with autism is mobile technology, particularly tablet devices (Lorah et al., 2015; McNaughton & Light, 2013).

The Augmentative and Alternative Communication (AAC) approach, which relies on symbols, pictures, or text, is especially valuable for users who experience difficulties with spoken language, as it provides a highly visual and intuitive means of expression (Fletcher-Watson & Happé, 2019).In addition, electronic daily planners and task management applications can help students with autism develop their executive functioning skills while gradually building the independence needed to carry out everyday tasks (Desideriet al., 2020; Spalla et al., 2024). By breaking tasks into manageable steps and embedding them within structured routines, these tools can help reduce anxiety and improve participation in both learning activities and daily undertakings (Knight et al., 2016).With recent digital advances, serious games and virtual environments are gaining increasing support as platforms for developing social competences in students with ASD (Carneiro et al., 2024; Grossard et al., 2017). The use of digital games for social skills training has been a growing area of research and holds considerable educational promise (Parsons et al., 2020). Interactive digital environments offer spaces where students can practise social behaviours without the fear of real world consequences, in a safe and controlled setting, thereby facilitating the development of both problem solving and communication skills (Grynszpan et al., 2017).

5.3. Emerging Technologies and Innovative Learning Environments

At present, the use of technological devices is making it easier for educators and therapists to support individuals with ASD by creating innovative digital learning environments (Virnes et al., 2015; Odom et al., 2015). Through ubiquitous media, technologies such as virtual reality (VR), augmented reality (AR), and interactive simulations are being increasingly used to cater to the cognitive, social, and emotional developmental needs of people with autism (Mesa-Gresa et al., 2018; Lorenzo et al., 2019; Simos et al., 2025b).

The use of virtual reality to simulate social contexts, which can be practised repeatedly at a pace that is comfortable for the individual with ASD, together with low stress exposure to real world social situations that promote the development of communication skills, are among the main features that make VR a valuable tool for enhancing social skills in individuals with autism (Parsons & Cobb, 2011; Lorenzo et al., 2019). Moreover, digital data tracking and learning analytics tools have enabled instructors and therapists to monitor students' progress and to adjust intervention methods according to individual needs and performance, reflecting a more personalised and data driven approach to autism intervention and inclusive education (Bondarenko et al., 2023).

The integration of ICT into autism education represents a significant step in the evolution of learning environments, one in which technological resources are combined with educational methods that have been established over time (Ploog et al., 2013; Odom, Thompson et al., 2015). By embedding digital technologies into intervention practices, it becomes possible to complement approaches such as equine assisted therapy alongside educational frameworks such as STEM and STEAM, thereby helping to build a comprehensive intervention model that addresses the multiple developmental needs of students with ASD (Grynszpan et al., 2014; López-Díaz et al., 2024).

6. STEM and STEAM Approaches in Autism Education

6.1. STEM Education and Inclusive Learning Environments

Recently, STEM education, which is a holistic approach that combines Science, Technology, Engineering, and Mathematics, has taken the lead in educational research and policy. STEM environments promote students to become problem-solvers, researchers who inquire, creators, and collaborators through STEM skills, aiming to equip learners for a future society that has advanced technology (Honey, Pearson, & Schweingruber, 2014; National Research Council, 2015). In inclusive education frames, STEM strategies have been initiated more and more as means to possibly help students with additional needs, i.e., ASD.

People with ASD have confirmed that they have certain abilities such as pattern decoding, logical analysis, and the skill of spotting the tiniest details that are very handy for carrying out STEM-related tasks (Wei, Yu, Shattuck, McCracken, & Blackorby, 2015).New research confirms that STEM learning isn't just about technical skills and specifically for students

with ASD, it can serve as a powerful tool for increasing engagement and fostering social connections (Li et al., 2025).Besides that, structured problem-solving, STEM technological tools, and hands-on experiments would be the best ways of learning for people from the autism spectrum. STEM settings most of the time have clear task definitions and provisions for organizations that are a plus for learners who rely on organized and systematic learning environments.Nevertheless, STEM guidance has not only been associated with cognitive gains, but it also seems to reinforce social behaviors in people with autism. Collaborating in STEM tasks will oblige kids to perform activities such as communication, exchange of ideas, and other social skill-involved tasks (Knight et al., 2016). Besides, a technology-based STEM environment can be a self-directed instruction that possibly attracts the learners as they can also control the pace of the learning only to the desired extent (Bers, 2018).

The inclusion of robotics, coding activities, and computational thinking within STEM education has also been associated with positive learning outcomes for students with ASD. Robotics-based learning environments, for example, have been shown to encourage engagement, promote collaboration, and support the development of social communication skills among children with autism (Diehl et al., 2019). These findings highlight the potential of STEM education to contribute to inclusive learning environments that recognize and build upon the strengths of neurodiverse learners.

While STEM focuses mainly on science and technology, the idea of STEAM education includes the Arts as an essential part of cross-disciplinary learning. The addition of arts is to encourage creativity, fantasy, and new ways of thinking in educational settings (Yakman& Lee, 2012).Research on ASD, STEAM education may be able to support a combination of problem-solving and creative expression. Visual arts, music, digital stories, and creative design may help people who are limited in their use of language for communication to express themselves emotionally (Bers, 2018; Peppler & Wohlwend, 2018).

STEAM environments stress more than just the cognitive side, including experiential and project-based work that connects different types of knowledge. Getting a chance to get in touch with scientific and technological subjects through artistic and creative ways, they not only understand but share their knowledge by making works of art, doing interactive stuff, etc. It can give autism learners a very wide range and smooth gradation in their participation and performance (Thomas, 2016; Riggs, 2017).Also, a mix of digital arts and creative technologies in STEAM has been associated with opening doors to both educational alternatives for children with autism and creative self-expression despite autism. Technological tools shared with students with ASD can act as a dual medium through which these students can interact with the outside world (Peppler & Wohlwend, 2018).

6.2. Integrating STEM, STEAM, and Innovative Technologies for Autism Support

A number of scholars have identified the integration of STEM and STEAM educational approaches with digital technologies as a promising frontier in interdisciplinary autism education research (Knight et al., 2014; Li et al., 2025). Advances in educational technology have opened up new possibilities across several domains, from robotics and virtual reality environments to gamified learning platforms and assistive communication tools (Boucenna et al., 2014; Iannone & Giansanti, 2024). These developments have contributed to the design of more inclusive learning environments that are not only functional but also responsive to the diverse characteristics and challenges presented by students with ASD (Parsons et al., 2020; Lorenzo et al., 2019).

Robotics based interventions have shown particular promise in supporting social interaction and collaborative learning among children with autism. Educational robots can serve as mediating tools that facilitate engagement and encourage communication between students and their peers. Studies have demonstrated that robotics activities may help students with ASD develop social skills, improve attention, and participate more actively in group learning environments (Diehl et al., 2019).Technologies such as virtual and augmented reality are also transforming the way learners practise social, emotional, and cognitive skills (Newbutt et al., 2020; Chen et al., 2022). These immersive environments function as rehearsal spaces in which individuals can explore social interactions, problem solving, and emotional regulation in a manner that substantially reduces the anxiety typically associated with real life social situations (Mesa-Gresa et al., 2018; Lorenzo et al., 2019).

Furthermore, when STEM and STEAM educational models are combined with experiential activities such as equine assisted therapy, they can support the development of comprehensive intervention frameworks that integrate technological training, physical activity, and social growth (Gabriels et al., 2015; Wei et al., 2013). What distinguishes these approaches is their capacity to address cognitive, affective, and social dimensions of learning simultaneously through multidisciplinary intervention (Odom et al., 2015; Grynszpan et al., 2014).The convergence of therapeutic interventions, digital technologies, and interdisciplinary educational practices therefore represents a viable and compelling direction for the field of autism education (Howorth et al., 2025; López-Díaz et al., 2024). By combining

experiential learning with emerging technological tools, educators and therapists can create environments that are genuinely inclusive: environments that honour the strengths, interests, and developmental needs of students with ASD (Virnes et al., 2015; Parsons et al., 2020).

7. Discussion

The outcomes of this research shed light on the role of multidisciplinary approaches in supporting students with ASD within contemporary educational and therapeutic settings. Combining conventional therapeutic methods with innovative educational models and technological tools opens up fresh avenues for addressing the complex developmental challenges faced by autistic individuals (Drigas et al., 2022).

ASD gives rise to challenges across multiple developmental domains, including communication, social interaction, emotional regulation, and adaptive behaviour (Lord et al., 2018; American Psychiatric Association, 2013). It follows that effective intervention often calls for a collaborative team of educators, therapists, and specialists working together to construct a comprehensive and well rounded support framework (Simos & Katsinis, 2026). Within this landscape, equine assisted therapy has emerged as a valuable therapeutic method that brings together physical activity, emotional connection, and social engagement (Bass et al., 2009; O'Haire, 2013). The rhythmic, multisensory nature of horse interaction offers experiential learning opportunities that can meaningfully address communication difficulties, emotional imbalances, and challenges with socialisation (Gabriels et al., 2012; Sterba, 2007). At the same time, the incorporation of ICT into special education has substantially reshaped pedagogical practice (Konstantinidis et al., 2009; López-Díaz et al., 2024). Research has shown that communication apps, visual aids, and digital learning platforms can support students with autism in more structured learning while also increasing their willingness to participate (Simos, 2025c).

This paper has reviewed evidence from the literature demonstrating that interdisciplinary approaches are integral to the creation of inclusive school environments for students with ASD (Odom et al., 2015; Wong et al., 2015). It highlights that while equine assisted therapy addresses the socio-emotional and sensorimotor needs of individuals with ASD through embodied, animal mediated experiences, ICTs and assistive tools, including virtual reality, social robots, and mobile applications, offer complementary, personalised interventions that extend therapeutic support beyond clinical settings (Beirat et al., 2025; Di Pietro et al., 2022). Virtual environments and augmented reality platforms have shown particular promise in training social skills, emotion recognition, and speech production for learners on the autism spectrum (Bekele et al., 2014; Chen et al., 2022). The convergence of these experiential and digital modalities aligns naturally with STEAM oriented pedagogies. Specifically, recent meta-analytic evidence confirms that STEM learning yields strong intervention effects for students with ASD, fostering problem solving, engagement, and social participation (Li et al., 2025). Integrating technology-enhanced, hands on activities with animal assisted approaches may therefore create a multisensory, interdisciplinary framework that capitalises on the structured, experiential learning environments in which individuals with autism tend to thrive (Gabriels et al., 2012; Wei et al., 2013; Howorth et al., 2025).

Equine assisted therapy stands out among complementary interventions for its capacity to combine physical activity with social interaction and emotional engagement (Bass et al., 2009; Gabriels et al., 2015). Interaction with horses offers not only multisensory stimulation but also opportunities for experiential learning that can foster the development of communication skills, emotional regulation, and social reciprocity among children with autism (DePauw, 1986; O'Haire, 2013). The therapeutic setting of equine assisted sessions may be especially effective in encouraging children with ASD to engage more actively in social exchange and to follow structured learning tasks. ICTs, for their part, provide media through which students can be engaged and content can be individualised according to different learning capacities, behavioural profiles, and interests. ICT based interventions make it possible for educators to create personalised learning environments that are sensitive to the unique cognitive and behavioural characteristics of students with ASD (Mitsea et al., 2022&2023).

Moreover, STEM and STEAM educational models offer interdisciplinary learning opportunities that bring together scientific inquiry, technological literacy, engineering design, mathematical reasoning, artistic creativity, and problem solving (Conradty& Bogner, 2018; Yakman& Lee, 2012). These educational paradigms are designed to be student centred, experiential, and collaborative, qualities that can be highly motivating and rewarding for students on the spectrum (Bers, 2018; Diehl et al., 2012). Integrating therapeutic riding with digital technologies and STEM/STEAM educational practices represents a meaningful step towards the development of intervention frameworks that weave together physical, cognitive, and socio-emotional learning experiences (Gabriels et al., 2015; Knight et al., 2013). What distinguishes such multidisciplinary interventions is their recognition that learning and development are

multidimensional, and that effective support should address all of these domains simultaneously (Sandbank et al., 2020; Schreibman et al., 2015).

Equine assisted therapy and other experiential interventions can work in tandem with technology based learning environments to provide movement opportunities and sensory engagement while also nurturing emotional connection (Baranek, 2002; Fine, 2019). When structured digital tools and STEM/STEAM oriented educational activities are combined with these experiential approaches, it becomes possible to foster communication, collaboration, and problem solving skills among students with ASD (Grynszpan et al., 2014; Parsons et al., 2020). The findings of this paper suggest that merging therapy, technology, and interdisciplinary educational practices offers a compelling pathway towards creating inclusive educational environments capable of supporting not only academic development but also the emotional well-being, social participation, and overall quality of life of students with autism (Simos & Fountoulakis, 2026). It is recommended that future studies continue to investigate holistic intervention models that combine experiential therapies, digital technologies, and innovative educational approaches (Wainer & Ingersoll, 2015; Zydney et al., 2020). By bringing together diverse perspectives and professional practices, educators and therapists may design more effective and inclusive support systems for individuals with Autism Spectrum Disorder (Rogers & Vismara, 2008; Wong et al., 2015).

8. Conclusion

ASD is a complex neurodevelopmental condition and the diverse needs of individuals on the spectrum, spanning cognitive, social, emotional, and behavioural domains, call for intervention approaches that are equally multidimensional. The rising prevalence of ASD has prompted researchers and educators alike to explore innovative strategies that draw on educational, therapeutic, and technological perspectives, with the shared aim of creating learning environments that are both more inclusive and more effective.

This research pursued two central objectives: (1) to provide a thorough theoretical grounding in ASD, and (2) to examine the potential of equine assisted therapy as a complementary intervention for children with autism. Therapeutic riding has been shown to enhance social interaction, emotional regulation, motivation, and motor coordination. The activities involved in horse riding and handling are inherently multisensory, offering individuals with autism meaningful opportunities for participation and engagement. Alongside these developments, the introduction of digital technologies has brought about significant changes in special education practice. Information and Communication Technologies can effectively support communication, structured learning, and individualised instruction for students with ASD.

STEM and STEAM education models offer further promising avenues for interdisciplinary learning. These frameworks expect students not only to acquire scientific knowledge but also to develop technological competence, creative thinking, and problem solving skills. Collaborative work, hands on learning, and familiarity with technology are central to these approaches, and such features appear to be particularly motivating and rewarding for students on the autism spectrum.Bringing together equine assisted therapy, digital technologies, and STEM/STEAM educational methods represents a productive step towards the development of multidisciplinary intervention models in autism education. Integrated approaches of this kind have a broader scope and can support not only academic learning but also social participation, emotional development, and overall quality of life for individuals with ASD. Future work in this area should examine the effectiveness of interdisciplinary intervention frameworks that combine experiential therapies with digital learning environments and innovative pedagogical approaches. It is equally important that research and practice continue to advance in tandem, with ongoing attention to the interplay between therapeutic and educational strategies. Through sustained dialogue and inquiry, the field may be well placed to develop inclusive learning models that widen access to education and foster greater autonomy for children with ASD.

Compliance with ethical standards

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Disclosure of conflict of interest

The Authors proclaim no conflict of interest.

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