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An Exploration of the Opportunities and Challenges of using Digital Technology to Support Social Communication in Non-Verbal Autistic Students in Three Saudi Arabian Schools

by

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Abstract

The global rise in autistic children has raised concerns and emphasised the need to tackle its core issues, including social communication (SC) difficulties. The intent of this research was to explore how digital technology is being implemented to support SC in NV autistic students in light of teachers' experiences and perspectives in mainstream inclusive schools in Saudi Arabia. The context for the research is Saudi Arabia, where digital technology integration for students with learning disabilities is increasing significantly under educational reforms aligning with Saudi Vision 2030. This issue clearly merits further investigation given the paucity of research relating to SC among NV autistic students in the Saudi context. In doing so, the study reported here further assessed the role and influence of digital technology in supporting pertinent SC precursors – in particular, joint attention, social orientation, engagement, and theory of mind – in NV autistic students keeping in view interaction between teacher's guidance, digital technology and impact of context in three different school setting.

The study was informed by Vygotsky's social constructivist theory (Vygotsky, 1978) to explore how teachers applied digital technologies across the curriculum and interactive activities to provide opportunities for SC of NV autistic students in a mainstream inclusive school setting. The research design drew upon multiple qualitative case study research methodologies, exploring the opinion and perception of eleven teachers using semi-structured interviews and observations of nine NV autistic students from three schools in Saudi Arabia. The findings highlighted the teachers' perspectives on the available opportunities and challenges as contextual factors that create or limit the conditions required to enable digital technology to support NV autistic students' SC in the classroom, followed by determining further contributions these digital technologies may provide in teaching and learning processes. Thematic analysis of the case studies indicated that technology tools, along with the mediation of other instructional and behavioural techniques, certainly facilitate, supplement, and reinforce the SC and learning of NV autistic students. The findings indicated the efficacy of digital technologies along with the use of instructional approaches and strategies such as scaffolding and prompting, motivating and engaging these students in shared and collaborative activities, in engaging students with social engagement, orientation, and theory of mind (ToM). The study further demonstrated influencing factors in use of digital technologies including the provision of technological accommodations and resources (applications specific for SC, Arabic versions of applications, provision of devices for each student for individual practices, and better

layout and facilities of resource rooms), the provision of assistance staff, and better teacher training and expertise. However, the contrasting views also indicated that the use and execution of digital technologies entail various challenges in the way teachers use them with autistic students, such as technical, support, and supervisory barriers., However, the extent to which the SC enabled by digital technologies may be applied to different situations remains questionable. The thesis concludes by identifying the factors affecting the appropriate integration of digital technologies for NV autistic students through the development of best practices in the use of such tools. The research suggests that future studies should focus on developing teachers' technological competencies specific for enabling SC. Moreover, the attention of authorities is directed towards the facilitation of better standard assessment procedures to characterise and integrate provisions, specifically the technological accommodations, for NV autistic students.

Keywords: Social communication, non-verbal autistic students, digital technologies, mainstream inclusive classrooms, Saudi Arabia.

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List of Abbreviations

SC	Social communication
MV/NV	Non-verbal/minimally verbal
APA	American Psychiatric Association
ASD	Autism Spectrum Disorder
BERA	British Educational Research Association
MoE	Ministry of Education in Saudi Arabia
KSA	Kingdom of Saudi Arabia
KFSHRC	King Faisal Specialist Hospital and Research Centre
ICDR	International Conference on Disability and Rehabilitation
DSM	Diagnostic and Statistical Manual of Mental Disorders
NTP	National Transformation Programme
CDC	Centers for Disease Control and Prevention
ICD	International Classification of Diseases
IDEA	Individuals with Disabilities Education Act
SHC	Saudi Health Council
SCFHS	Saudi Commission for Health Specialties
CBAHI	Saudi Central Board of Accreditation of Healthcare Institutions
IEP	Individual Educational Plan
PECS	Picture Exchange Communication System
JASPER	Joint attention, symbolic play, engagement, and regulation intervention
EMT	Enhanced milieu teaching
US	United States
WHO	World Health Organization

Chapter One: Introduction

1.1. Research background

Autism is among the most prevailing neurodevelopmental disorders globally (Oshodi et al., 2016). Autistic individuals are bearers of hallmark characteristics, especially those unable to communicate and socially interact or connect with others, referred to as social communication (Leaf et al., 2016) that further relates to their inability and challenges of interaction, collaboration, and developing social skills. Moreover, autistic children are susceptible to the development of comorbidities and other learning difficulties, attention deficits, and cognitive difficulties (Matson and Goldin, 2013). As a result, educators, teachers, and practitioners charged with improving these difficulties are constantly challenged to determine effective ways of developing academic, social, communication, and behavioural improvements in these students. It is reported that the actual prevalence of autism has remained consistent over the past 70–80 years (O'Nions et al., 2023). According to a current publication by the US Centers for Disease Control and Prevention (CDC), a 15% increase in the predominance of autism has been reported globally (Autism Speaks.org, 2018). According to the World Health Organization (2018), the global prevalence of autistic children is 1 in 160. Reports from the WHO revealed that every 6.25 individuals out of 1000 are autistic. Parsons et al. (2020) suggest that the global percentage of autistic children with obvious learning difficulties constitutes about 50% of this group (p.106).

The primary diagnostic marker of this group is the persistent impairment in social communication, including language development (expressive and receptive) and social interactions, with additional repetitive and challenging behaviour and constrained interests and activities (American Psychiatric Association APA, 2013; Tsai et al., 2012). Factors such as demographic, socioeconomic, and geographic differences play a considerable role in assessing autistic characteristics and prevalence across nations. Due to the number of factors associated with the condition and its heterogeneous nature, the definitional construct, diagnostic criteria, and assessment models for autistic individuals are not unified (Happe and Frith, 2020). There is a lack of consensus on the aetiology of autistic traits, but many claim its origin is connected to both the environment and genetic factors. Almirall et al. (2016) explicate that there is a significant need of reconsideration of the fundamental opinions and principles that govern diagnostic procedures, and have considerable influence on determining the validity of autism as categorical diagnosis. This also relates to the questions raised by numerous researchers on retuning the current conceptualisation of autistic traits that is linked to a heterogeneous behavioural disposition

and discrepancies of research findings as the most debated aspects leading to existing gaps in the research in the field of autism.

In recent times, scholarly literature has brought attention to the urgent necessity of examining autistic children who possess severely restricted verbal capabilities. This majority of autistic children typically exhibit the delayed onset of verbal communication. This particular subgroup of autistic individuals has been identified as being significantly underrepresented in the existing body of research on interventions. Additionally, around one-third of these children will continue to have limited or no verbal abilities throughout their whole lives, using very few or no words (Stedman et al., 2019). Over the course of nearly six decades, there has been a limited number of studies that have specifically examined interventions aimed at improving first word production in this particular demographic beyond the age of two years. Without clear and explicit criteria, as well as evidence-based treatments, autistic children may be subjected to interventions that are useless or misdirected.

Different terms are used to describe non-verbal autistic individuals: minimally verbal, pre-verbal, non-vocal, and non-verbal (Koegel et al., 2020). Non-verbal autistic children are characterised as having minimal expressive language acquisition and severely impaired usage of spoken words triggered by interference in their social cognition abilities (Fletcher-Watson and Kasari, 2014; Koegel et al., 2020). Because social communication difficulties limit the learning and cognitive abilities of autistic individuals, the sparsely researched non-verbal autistic population also needs to be addressed in the domain of SC skills development (Bal et al., 2016).

SC difficulties, one of the prevalent characteristics in all autistic children, may exacerbate if necessary support is not provided. According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), social communication difficulties, in particular, are the main problem in autistic individuals (APA, 2013; DSM-5, 2013) that is said to commonly persist during individuals' school age, limiting their academic and social progression (Qi et al., 2018). The early development of social communication skills is associated with the development of further language and social skills (Wilson, 2013) and other learning and cognitive skills in autistic individuals (Dadgar et al., 2017). A defining autistic characteristic i.e. social communication challenges are of utmost concern for researchers and practitioners, and increased efforts have been directed towards finding effective interventions to improve these skills (Bradshaw et al., 2018). In view of the mentioned significance of SC, the focus of the current study is on the primary developmental precursors of SC, i.e., joint attention, social orienting, and ToM in autistic individuals. Various studies theorise that joint attention plays a critical role in later language and

theory of mind development that are necessary for SC skills development (Alpern, 2012; Vaiouli et al., 2015). The role of joint attention and social orientation as precursors refers to their contribution toward ToM, leading to the acquisition of SC skills (Franchini et al., 2017). Although joint attention is the precursor for the development of early ToM and early SC skills, and further lays the foundation for development and serves as a post-cursor of SC skills such as social activity and language development (Baraka et al., 2019). The SC learning profile of autistic students is significantly linked to their cognitive ability to identify and interpret the state of mind of other people, referred to as 'theory of mind', which is a crucial ability for joint attention and social engagement (Fletcher-Watson and Happé, 2019). The following section will highlight the role of ToM in the development of SC skills and how the difficulties in ToM can limit the development of SC.

In the context of the existence, prevalence, and challenges associated with autistic individuals, educational facilities and systems globally are constantly working on developing novel solutions to address the difficulties exhibited by autistic children (Lu et al., 2021). The increasing number of research publications regarding the effectiveness of digital technologies for autistic children in the educational context indicates that these technological accommodations are gaining attention as promising intervention tools for autistic students (Roberts-Yates and Silvera-Tawil, 2019). Considering the novel and contemporary solutions, policymakers, educational leaders, and school administrators are in consensus over the adoption and use of digital technologies and generally recognise the contribution of technology towards learning (Cagiltay et al., 2019) and its effectiveness in addressing the learning difficulties of different groups of people with special educational needs, including autistic children (Grynszpan et al., 2014). In response to this, the growing efforts to integrate advanced technological solutions are motivating special educators to endorse scientifically appropriate interventions to address SC difficulties in autistic students (Lian and Sunar, 2021; Goosen, 2023).

The increasing advent and adoption of digital technologies such as tablets and similar smart devices are found to assist autistic children in developing their social communication skills through various software and applications and transforming pedagogical and instructional approaches (McNaughton and Light, 2013; Clarke et al., 2015; Aspiranti et al., 2020). The novelty and variety of solutions these developing digital technologies offer are so versatile, relative to traditional approaches used in schools to address their difficulties, that students with developmental and learning difficulties, including autistic children, exhibit a distinct attraction and affinity towards their use (Kagohara et al., 2013). Innovative developers and implementers are coming up with effective collaborations to further improve the designs of technologies, applications, interventions, and approaches

to incorporating technologies to strengthen and improve the communication and social collaboration of those with these challenges (McNaughton and Light, 2013). Moreover, in the given context of developing SC skills in autistic students, the emerging technologies are found to augment the execution of interventions designed for SC skills in the educational setting (Watkins et al., 2017). The growing demand for these novel solutions is associated with the growing autistic population in the educational context and the dire need for specialised resources (Cera, 2015). However, it is important to explore and determine the fundamental features, use, efficacy, and execution of these technological tools for use with autistic students and the challenges associated with the effective use of these tools in the educational context.

At present, technological advancement has mainly focused on developing solutions for autistic individuals and has overlooked the evaluation of these technological interventions for NV autistic children (Tager-Flusberg and Kasari, 2013). Due to a lack of research, traditional interventions for NV autistic children are inaccessible (Almirall et al., 2016), and the possibility that these autistic children won't improve could prolong their SC challenges (Shire et al., 2014). Hence, this dearth of research and technological development for non-verbal children is of utmost concern for researchers, teachers, parents, and societies.

An important dimension in the context of autism as a complex group of individuals with communication and social challenges is determining the role of technology in developing these skills. First, it is known that autistic students may have challenges collaborating and interacting. Second, it is assumed that autistic students have a strong affinity toward technology, and technology is an effective medium for interaction and collaboration. Third, the role of language is important in social interaction and collaboration, and coming back to the focus of the current study, the question is raised of how social interaction and communication can develop when language is not developed. This relates to the underpinnings of Vygotsky’s paradigm of social constructivism and development that emphasises the role of social interaction with others as being imperative for social and cognitive development. This motivates the current research to address the gap in this domain and to determine the role technology can play as a mediator. With the focus of the current study on the use of digital technologies for NV autistic students, it aims to identify strategies to engage students and motivate them to enable SC and be able to communicate with others.

In response to the increasing integration of digital technologies in special education and keeping in mind the prevalence of autistic children in the Kingdom of Saudi Arabia (KSA), there is a proliferation of focus directed towards the provision of advance technological

solutions and resources in educational institutes and a major shift in pedagogical approaches occurring in mainstream inclusive settings, where traditional approaches to education and conventional interventions for children with learning challenges were the norm.

Furthermore, within the academic research context of Saudi Arabia, the topic of digital technology use for autistic children to manage their SC difficulties, specifically those who are NV, would be one of its own kind, and as far as the researcher is aware, there is no prior research specifically accommodating these aspects of SC difficulties for NV autistic children and managing them with use of digital technologies. Therefore, this study seeks to explore the use of digital technologies to manage SC difficulties in NV autistic students in Saudi Arabia, with a focus on teachers' opportunities and experiences of using technological accommodations in these students and how technology helps them manage SC difficulties, with a specific focus on joint attention, social orientation, and theory of mind.

The following section elaborates the diagnostic procedures, current services, educational provisions and digital resources used with autistic students in the Saudi Arabian context.

1.2. Saudi Arabia in context: Digital technologies for autistic students

The context for the research is Saudi Arabia, where the adoption of technology for the wellbeing of students with learning disabilities is increasing significantly (Alnemary et al., 2017). Firstly, it is pertinent to mention the escalating number of autistic children in KSA. The literature review reveals that Arab countries have a significantly higher number of autistic children than other developing countries worldwide (Taha and Hussien, 2014). There is a dearth of research addressing the prevalence of autism in different cities of KSA; consequently, there is little understanding and recognition pertaining to the prevalence of autistic children, even in the major cities of KSA (Sabbagh et al., 2021).

In this context, the most recently reported number of confirmed cases was 42,500 in 2002, with many undiagnosed cases (Sabbagh et al., 2021). Furthermore, there isn't a lot of information about how common and well-known autistic people are in KSA because socioeconomic status, family structure, and demographic traits vary and aren't always clear between cities in the country (Sabbagh et al., 2021). According to a recent study by AlBatti et al. (2022), the prevalence of autistic children between 2 and 4 years of age is 1:40, with males more affected than females at a ratio of 3:1``. However, research has shown that the rate of autistic individuals in the country continues to escalate (Khalil et al., 2020). Parents, teachers, and facilitators in KSA are becoming increasingly concerned

about the growing autistic population, and the introduction of new technical standards lacks adequate research to fully understand their potential benefits (Aldabas, 2021).Alenezi et al. (2022) indicate that there is variation in prevalence rates across regions and an inconsistency in the services presently available for autistic individuals in Saudi Arabia. In addition to the lack of support services, the available services are difficult to access, with a lack of local provisions for screening and community resources for autistic children that are not up to the required quality standard and are expensive. In addition, national experts need to agree on appropriate assessment and management standards for autistic individuals. The existing body of research pertaining to the diagnosis of autistic individuals and the various factors influencing it is predominantly derived from developed Western nations, but offers limited systematic insights into the understanding and management of autistic children in other regions, with Saudi Arabia being a notable example (Alnemary et al., 2022). A variety of factors, with a particular focus on the autistic child's family characteristics, affect the diagnosis of autistic children in Saudi Arabia. According to Alnemary (2022), it is frequently observed that autistic children in Saudi Arabia are diagnosed before the age of 5. This finding is consistent with previous scholarly research that suggests early identification of autistic children, especially those exhibiting moderate to severe characteristics and those whose parents have higher levels of educational achievement. However, reports suggest that the start of therapies and training for autistic children may face delays after the confirmation of analysis, due to factors such as parents' educational attainment and understanding of autistic characteristics, as well as their annual income and geographic location within the country (Al-Dakroury et al., 2022).Existing research also reports that diagnostic services in other countries are comparatively superior or offer more convenient accessibility when compared to those available in Saudi Arabia (Abualhommos et al., 2022; Zuckerman et al., 2021).

Alenezi (2022) reported that there is currently involvement from multiple authorities in the process of providing care, education, and empowerment for autistic individuals. Well-trained and specialised healthcare professionals are authorised for the initial screening and diagnostic services. These professionals include general paediatricians, psychiatrists, child psychologists, developmental–behavioural or neurodevelopmental paediatricians, pediatric neurologists, and child psychiatrists working within organisations that are affiliated with the Ministry of Health (MoH) or have been accredited by public authorising entities such as the Saudi Health Council (SHC), the Saudi Commission for Health Specialties (SCFHS), and the Saudi Central Board of Accreditation of Healthcare Institutions (CBAHI). The diagnostic and screening services currently offered in Saudi Arabia indicate that a number of professionals have received training in utilising the Autism Diagnostic Observation Schedule (ADOS) and the Autism Diagnostic Interview (ADI) as

tools for diagnosing autistic children. Al-Dakroury et al. (2022) assert that only the ADI test undergoes translation into Arabic. The variation in the implementation of these services across different capacities can potentially be ascribed to a dearth of explicit guidance, a scarcity of specialised professionals, and the accessibility of verified tools. As a result, there is an increasing need to develop a national policy to tackle the inadequate service delivery for children with autism.

In numerous countries, there has been a shift in viewpoints regarding the education of individuals with special educational needs and disabilities (SEND), specifically autistic children, in recent decades. This change has prompted a demand for a comprehensive understanding of the support and services available in educational settings (Ainscow, 2020). The Kingdom of Saudi Arabia observes a significant discrepancy between the demands placed on autistic individuals and the current resources available to meet these needs.. Despite being classified as a developed economy, Saudi Arabia predominantly focuses its service sector activities within its primary urban centres, namely, Riyadh, Jeddah, and Dammam. Furthermore, empirical evidence has indicated that the services provided frequently fall short in fulfilling the expectations and needs of families. In a recent study conducted by Alnemary et al. (2017), an assessment evaluating the quality of services provided for autistic individuals disclosed that approximately 75% of the families rated the services as either not acceptable or unsatisfactory. Similarly, Khan et al. (2020) examined the accessibility of services in Saudi Arabia and found that they present challenges for autistic individuals to access autism centres that are conveniently located, as well as a lack of access to private educational institutions specifically designed for autistic individuals in close proximity to their residential areas.

The early intervention programmes available prioritise various essential domains, such as language acquisition, play proficiency, social interaction, activities related to daily functioning, and the effective handling of challenging behaviours. According to Athbah (2022), the current state of the services provided is inadequate. This suggests there are areas for improvement and development under responsible authorities. Since the centres were not built on scientifically sound principles that meet the needs of autistic children, there are also space issues. The lack of supervisory support limits educational adjustments and has significant financial consequences. Additionally, there are few educational settings based on educational foundations and few facilities for storing materials and resources for each child. Saudi Arabia uses observation and interviews to diagnose and evaluate the prevalence of autism due to a lack of standardised measures. The improvement in outcome may be due to diagnostic procedures performed in Ministry of Social Affairs-affiliated specialised centres or medical institutions.

The fact that autistic children learn, speak, and behave differently than other children makes it necessary for teachers and parents to provide them with specialised attention and learning techniques suited to their special needs (Lindsay et al., 2013). Prior research has identified various challenges faced by teachers and parents when it comes to effectively addressing the needs of these students. Thus, it is important to address this gap and identify what important points are missing in the Saudi context when it comes to using technological tools, facilities, and the configuration of the learning context for these students, as these factors significantly affect the overall development of their different skills. Khalil et al. (2020) assert that it is crucial to have an ideal environment for the development and learning of autistic students in order to address their complex communication and social challenges.

Asiri (2020) notes that multiple developmental plans for technological integration, particularly Saudi Vision 2030, increasingly highlight the role of technology as a key facilitator in various domains and fields, fostering the development of novel competencies, skills, and expertise, and enhancing the execution of various educational tasks. In alignment with these notions and developmental steps towards technology, it is important to assess the technological role in light of policies, strategies, and programmes devised by the authorities. This motivates the current study to engage in a comparative and comprehensive analysis of different practices, ways of using technology, and the availability of technological resources across different regions of Saudi Arabia. In addition, the trend of inclusion into the mainstream in KSA mandates the assessment of facilities that are being considered to effectively use digital technologies in Saudi schools. Moreover, research opportunities also need to assess teachers' competencies and expertise with regard to the use of technology. Another reason for conducting research in the Saudi context is that a recent agreement has been signed by the Centre for Autism Research at King Faisal Specialist Hospital and Research Centre (KFSH&RC) to facilitate research with autistic individuals, develop training programmes for teachers, and promote awareness through workshops to overcome obstacles faced by autistic children towards the use of technology (KFSHRC, 2022). The Centre for Autism Research at King Faisal Specialist Hospital and Research Centre (KFSH&RC) recently held an international conference on disability and rehabilitation (ICDR) in KSA, focusing on the pervasiveness of autism. The conference also addressed the technological solutions and educational needs of autistic children. The conference sought to explore the role and contribution of technological implementation in KSA schools for autistic children and assess its role in encouraging the use of language, mediating social interaction, and motivating collaborative play.

Therefore, in light of the above background, the underlying research aims to address the gap left by prior studies with a particular focus on NV autistic students – the most neglected subgroup of autistic individuals, particularly their SC profile – and how they can benefit from the use of technology in the Saudi context. Much of the existing evidence highlights that, with the advent of Vision 2030 and the development of contemporary educational policies, paramount importance is being given to addressing the need for augmented facilities in special education centres across the country (Al-Sughair, 2015). Currently, the Ministry of Health supports the development of new autistic centres in Riyadh, Jeddah, and Dammam (Al-Sughair, 2015), and educational programmes are being promoted to help autistic students address their learning needs independently.

1.3. Model of disability

The prevalence of autism has changed society's view of disability (Grinker, 2020). However, fundamental disagreements in autism research, such as the ontology of autism (what 'autism' is; e.g., Hollin, 2017; Chapman, 2020), whether autistic traits are a unitary construct, and the epistemology of autism research, present significant challenges. Despite significant financial investment, autism research is uncertain and contested, which may explain its popularity (Hollin, 2017). As part of the context of this research, it is crucial to look at autistic challenges and difficulties through the perspective of disability models. A view of the wider context of how we perceive autistic people is part of our understanding of how they are educated. The disability models manifest the notion of 'identity' pertaining to the perspective of disability. This analysis includes an exploration of how autistic challenges are comprehended within both the medical and social models of disability, and the potential influence these models may have on the construction of autistic identity. The medical model of disability is a framework designed to enhance or augment the capabilities of individuals with certain disabilities, with an emphasis on therapeutic approaches that address deficits (Anderson-Chavarria, 2021; Shyman, 2016). Although medical therapies have been shown to provide life-saving benefits and enhance the functioning of individuals (Shyman, 2016; Anderson-Chavarria, 2021), it is important to acknowledge that these interventions may also have a negative impact on the emotional wellbeing of individuals with certain impairments owing to their deficit-based approach.

Consequently, there has been a notable transition towards acknowledging the social model of disability, which entails the growing integration of this perspective into governmental, institutional, and healthcare practices. This shift is particularly evident in communities, where disabilities such as autistic challenges are no longer perceived from a deficit-oriented standpoint.

The social model of disability further negates the negative attitudes and instances of social exclusion within the context of the autistic community, with the goal of transforming the environment to foster more inclusivity. Likewise, the philosophy underlying the social disability model aligns with the utilisation of identity-first language (IFL), as opposed to person-first language (PFL), to denounce the deficit-based medical framework of disability (Anderson-Chavarria, 2021), that results in highlighting their autistic difficulties through the use of the phrase "person with autism". PFL may portray autism as a disability or a negative, which may perpetuate stigma and ableism (the belief that individuals with certain learning and neurodevelopmental challenges are different to others who perform normal (Bottema-Beutel et al., 2020). Thus, IFL may be an empowering choice favored by many autism self-advocates who believe autism is a difference, not a difficulty (Sabatello, 2019; Shakes and Cashin, 2020). In the same way, autistic individuals who perceive autism as essential to their identity are more likely to support IFL (Botha et al., 2020).

Owing to the inclusiveness the social disability model provides for autistic individuals, the current study adheres to its adoption. However, the non-participation of autistic students in the research as research participants may apparently reflect a lack of epistemic authority and genuine engagement of autistic children in the creation of autism knowledge (Hens et al., 2019). Moreover, owing to the research focus on NV or MV autistic children, their apparent non-participation may be subject to controversy and misalignment with the social model of disability. However, the participatory approach for the active inclusion of NV autistic students was limited, as their limited means of communication as true co-researchers was felt likely to be tokenistic.

Lebenhagen (2019) presented an interesting argument that aligns with the researcher's intent of the current research, i.e., researchers who practice ethical listening increase opportunities for NV autistic participants. Therefore, being a responsible researcher, one potential methodological technique that I intended to follow throughout involved conducting research "with" NV autistic children. Curran and Runswick-Cole (2014) explained this perspective of researchers' active engagement in activities alongside participant children, observing and documenting their actions and behaviours as a means of eliciting their perspectives on their experiences and preferences. Therefore, following these three fundamental principles, I have paid attention to all possible means of communication during observations, such as nonverbal gestures, paying attention to teachers' gestures and requests, making requests using devices, turn-taking, and nonverbal cues (body movements, sitting or moving towards a table, chair, or door) that they made as a response. I believe that, in this way, I ensured the inclusion of their voice in the research and granted them the agency to determine the modes of their participation.

However, in doing so, Hills et al. (2019) talk about the fundamental ethical considerations that underlie the consent and involvement in the research process. Therefore, proxy consent, i.e., from the parents of nonverbal autistic children, was obtained by explaining to them that the ethical inclusion of their NV autistic child for research purposes would develop an end product that reflects their child's education needs and requirements.

1.4. Use of terminology

Language influences the identity of people with disabilities, evolving over time due to cultural changes. People with disabilities have diverse preferences for language. Negative language choices can negatively impact autistic individuals due to stigma and prejudice. Therefore, we should adopt a critical perspective when examining the terminology for autistic individuals (Dwyer, 2022).Journal editors often instruct disability researchers on language usage, i.e., person-first language or identity first language, but advocates for identity-first language argue that the usage of person-first language may harm the cultural identities of individuals with disabilities. The disability community, including disability rights advocates, is increasingly adopting an identity-first language, rather than the person-first language. Autistic self-advocates, many of whom have scholarly backgrounds, embrace this approach (Andrews et al., 2022). Identity-first language, also known as disability-first language, places the disability before the person in language phrases, such as "autistic individuals.

The medicalisation of autism is a prominent phenomenon, wherein the autistic diagnosis is characterised by subjectivity. Consequently, societal norms deem many autistic features inappropriate (Sulaimani and Daghustani, 2022).The social model posits that autistic challenges represent a neurological variation inherent to the human condition rather than a problem (Ferrigon and Tucker, 2019). Currently, advocates and scholars in the autistic community, in an effort to address stigma around autistic challenges, acknowledge the use of an identity-first language that encompasses all the aspects of one's identity and inclusiveness (Taboas et al., 2023). In the context of the current study, the stigmatisation and prevalence of autism in Saudi Arabia call for the adoption of an autistic-friendly approach in research studies to mitigate stereotypes and discrimination (Alshaigi et al., 2020). Therefore, aligning with the preferences of the autistic community, an identity-first strategy will be adopted in order to avoid the awkward focus on disability that comes with the use of person-first language. Therefore, the terms 'autistic' and 'nonverbal (NV) autistic students' will be used. In other cases, 'NV autistic students/individuals or children,' will be used when referring to the social contextual issues and experiences related to their self-identification, acknowledging their diversity.

1.5. Problem statement

The evidence from existing research has predominantly demonstrated an increased recognition and understanding of young toddlers, preschoolers, and young and adult autistic individuals in the verbal category, considering the ease of evaluating these autistic categories through the use of standard assessment tools (Elsabbagh et al., 2012). However, many aspects of the challenges associated with autism remain poorly addressed, including those in the non-verbal category, known as "the neglected end of the spectrum" (Tager-Flusberg and Kasari, 2013). This category is estimated to constitute 30% of the total percentage of autistic children (Baxter et al., 2015; Tager-Flusberg and Kasari, 2013), and very little is known about the developmental profile of this category, particularly social, communicative, and behavioural patterns. Moreover, there is also a lack of studies exploring the use of digital technologies with NV autistic children and teachers' understanding and perspectives of the use of these technological resources, and their affordances to help overcome SC challenges, particularly joint attention, social orientation, and ToM, in the Saudi context.

In addition, SC difficulties have significant functional consequences, arise early in development, and are central to the diagnosis of autistic characteristics. Thus, SC is a common therapeutic focus for young autistic children (Fuller and Kaiser, 2019). Numerous autistic children struggle with SC, including issues with social-emotional reciprocity, NV communication, and interpersonal relationships (APA, 2013). The present body of literature on SC has identified a number of areas where agreement exists among scholars. Firstly, SC difficulties are universal in autistic children, regardless of whether or not they experience delays in structural language development. Several of the prevailing SC challenges that manifest early on are observed in joint attention, NV social behaviours, and the acquisition of spoken language (Barbaro and Dissanayake, 2009). Secondly, it has been established in previous research that early SC behaviours, including imitation (Ingersoll, 2008) and shared attention (Charman, 2003), are conceptually and empirically associated with the subsequent development of more intricate behaviours, including language and ToM. hirdly, studies have demonstrated that providing suitable assistance can mitigate the intensity and consequences of SC difficulties (Fuller and Kaiser, 2019). There is an increasing body of research supporting the efficacy of both developmental and naturalistic developmental behavioural techniques in supporting SC skills in young autistic children (Crank et al., 2021; Sandbank et al., 2020; Tiede and Walton, 2019). Although the aforementioned areas of agreement pertaining to SC are significant, there are still numerous notable gaps that need to be addressed, and one of them is their identification and improvement in NV autistic children through the use of technology, rather than

behavioural and naturalistic techniques. One way to close this gap is to determine the extent to which they vary in NV autistic students and how they impact their social-emotional reciprocity, social relationships, and understanding of different relationships in different contexts (Ohara et. al., 2019). This raises the need to understand contemporary developments in interventions and approaches to address these difficulties, with a specific focus on how relevant technology-mediated practices are being executed according to varying stages of development and difficulties in these students.

Keeping the aforementioned stance in focus, it is pertinent to reflect on these issues in light of this study context, i.e., Saudi Arabian educational setting. Despite the increasing integration of technological resources and facilities, there is a paucity of studies concerning the use of digital technologies, particularly with regard to how they can be used to address the SC challenges of autistic students. The existing studies in the Saudi Arabian context have mostly engaged with the services provided for autistic children in non-educational contexts, or with the cultural challenges faced by parents of autistic children. Those studies that have investigated the educational context used a quantitative approach. They lacked the rich narratives that could be gained through qualitative methods to explore the insights, views and experiences of teachers, faculty staff and students of the actual use of digital technologies along with other educational practices and approaches for managing the social and communication challenges of autistic students. In addition, most of the studies focused on the perceptions and attitudes of teachers and parents towards the use of technology for autistic students and the challenges they face with using these technologies with autistic students.

Moreover, there has been little discussion to date around how digital technologies are specifically helping NV autistic students in inclusive educational setting with their SC difficulties. This again underlines the importance of conducting a study that focuses mainly on the experiences of teachers regarding the technological opportunities they have been given by authorities and how they have been employing them in educational settings with NV autistic students to manage their SC difficulties. There is a need to conduct research that particularly argues for a focus on exploring teachers' experiences and understanding the role of digital technologies in helping NV autistic students with this broader construct of SC difficulties. This further necessitates the need to explore the potential facilities, opportunities, and barriers to the successful execution of digital technologies with school-aged NV autistic children. Research needs to address how digital technologies can be used to guide teachers as facilitators to manage communication and social difficulties and their ability to foster joint attention, social orientation and ToM, which is a core feature of SC skills (Patterson et al., 2012). Prior literature on NV autistic children has also failed to

evaluate the effectiveness of SC interventions and technologies for this subgroup (Slušná et al., 2021; Arnold, 2021).

It is worth noting that the widespread adoption of technology is occurring at an unprecedented rate in the KSA (Alnemary et al., 2017; Alotaibi and Almalki, 2016; Alzahrani and Brigham, 2017). As a multitude of research exists on the integration, adoption, and use of technology, the Saudi authorities and policymakers have significantly accelerated their initiatives and efforts toward the facilitation of technological tools in general and special education in particular (Alghamdi and Holland, 2020).

Therefore, the current study aims to respond to the gap in the literature regarding the use of technological devices in mainstream inclusive setting. It is the first to explore the understanding and experiences of teachers in supporting NV autistic students with their SC challenges through use of digital technologies as well as identifying the challenges and opportunities that facilitate the use of these technological resources within the context of the Saudi educational system.

1.6. Aims and objectives of the research

Prior studies have established that many autistic students have a keen interest in and an affinity for technological devices (Hourcade et al., 2013) due to the consistency they offer. Technological devices also require fewer human interactions, which can be a source of anxiety for some students (Boucenna et al., 2014). The multisensory attributes of touch, visuals, sound, and movement accelerate their focus and attention; this motivates them to use digital technologies for interaction (Ploog et al., 2013). It has also been established that a technology-assisted context improves the learning of autistic children, even as early as 1973 with the use of a basic computer device (Colby, 1973). This highlights two important points: on the one hand, technology is an attractive and effective medium for learning and communication; but on the other hand, students' preference for technology is also associated with the fact that it entails fewer interactions with others, and they can thus avoid dealing with the unpredictability of real-life situations. Moreover, there is a considerable argument in favour of identifying the options that have the greatest potential in the domain of technological solutions, e.g., speech-generating devices (SGDs), iPods, or tablets, as they are most compatible with the learning needs of NV autistic students (Van der Meer et al., 2011).

The underlying research is directed towards examining improvements in SC and aims to advance the domain of social communication improvement by conducting a comprehensive analysis of extant literature and efficacious interventions. Despite extant evidence

suggesting progress in social communication with technology, the mechanisms through which teachers facilitate such advancement remain ambiguous. Thus, this research focuses on examining the integration of digital technology within the pedagogical framework of Saudi schools, serving as a pivotal precursor for interpreting potential ways to enrich SC practices.in doing so, it will facilitate teachers and practitioners to tailor the techniques and strategies effectively, thereby optimising activities oriented to manage SC difficulties for NV autistic students. Moreover, a thorough comprehension of SC would enable identification of gaps and areas for further exploration of SC practices through integration of digital technologies.

Hence, in order to pursue the above-mentioned intent, the research aims to explore teachers' perspectives and experiences of the use of digital technologies in supporting SC in NV autistic students and how they perceive it in relation to traditional approaches. The study also aims to explore how teachers employ technology to manage SC difficulties. Moreover, it further aims to explore how the use of technology alone or in combination with other traditional approaches impacts the SC skills of NV autistic students in different schools in KSA. Finally, the study aims to assess the mode of interaction between teachers and students and how it fosters or inhibits the use of different approaches, including instructional technological techniques.

Two distinct perspectives guided the study's objectives.. On the one hand, a robust body of literature posits that traditional instructional techniques can help address autistic students' learning difficulties, including their SC. Conversely, there is encouraging evidence that suggests the use and integration of technological tools can enhance SC responses.. Teacher-centred learning methodologies produce more learning gains and teacher–student interactions through instructional dialogues, which are an effective means of improving SC performance in autistic students. This approach highlights the need to explore how technology can contribute to helping NV autistic children with their SC challenges (Almirall et al., 2016; Grynszpan et al., 2014). Therefore, this directs the following research objectives:

- To explore teachers' experiences, opinions, and understanding of the use and significance of digital technology in managing NV autistic students' SC difficulties in the Saudi context.
- To explore teachers' understanding of the use of digital technologies (use of various techniques and strategies) for managing NV autistic students' SC difficulties in mainstream inclusive schools in the Saudi context.

- To explore how NV autistic students use digital technology to express their social and communication needs in a classroom setting in the Saudi context
- To explore the positive contribution of digital technology implementation to the overall learning and teaching of NV autistic children in the Saudi context.
- To determine the most important factors, i.e., the challenges and barriers affecting the implementation of digital technology for NV autistic children in the Saudi context.

1.7. Significance of the study

Recent studies in the autistic context have emphasized the need to establish a research base for autistic children with significantly limited verbal abilities, also known as NV autistic children, due to the unacceptably low reporting of this subgroup in the existing literature (Bryan, 2020).It has been identified that in the span of the last 60 years, a very limited number of studies have been conducted that focus on interventions, approaches, and strategies that could contribute positively to enabling communication and social interaction in these children (Green and Garg, 2018). Due to this dearth of information and objective data, specific and effective guidelines are also lacking, meaning that this subgroup may be receiving ineffective or even incorrect interventions and training. The increasing rate of autistic children in Saudi Arabian schools is raising concerns for educational facilitators and various autism centres, pushing them to introduce empirically validated interventions and technology (Ministry of Education, 2015). The present study would be a significant contribution to the knowledge in this field and the first study to explore the perceptions and experiences of teachers and students using digital technologies to manage the SC difficulties of NV autistic students.

The focus of the study is on technological initiatives, integration, and execution in the Saudi context across three different schools from two cities. It has already been established that technology is being integrated into the educational settings of Saudi Arabia in reaction to contemporary plans and initiatives devised by the educational authorities. However, there is still an urgent need to explore the actual practices taking place, the mechanism through which teachers think improvement in SC takes place through their integration of digital technologies, the contribution of technology, and the effects of these tools in supporting the communication repertoire and social interaction of NV autistic students. The current study's analysis is significant and distinctive, with a focus on how teachers manage SC difficulties as well as examining outcomes such as joint attention, social orientation and ToM.

The current study aimed to explore the role of digital technologies in managing the SC challenges faced by NV autistic children in KSA, which would help contribute to the gap in existing literature on this perspective. Several prior studies have examined the significance of SC skills in autistic children (Pickett et al., 2009), for example, joint attention (Mundy et al., 1990), social orientation (Kasari and Sterling, 2013; Bishop, 2015), and other improvements in SC skills (Paul et al., 2013) through relevant language interventions and speech-generating devices (Shire et al., 2014). Therefore, this research focuses on enabling and supporting SC skills in NV autistic students through digital technologies. Second, it discovers how these technological alternatives can be a potential solution for NV autistic children in Saudi Arabian schools. Third, it evaluates how technology serves as a facilitator for the precursors of SC including joint attention and social engagement. Finally, it offers recommendations for future research on technological interventions for NV autistic individuals in order to consider other missed areas.

1.8. Research motivation

The proliferation of autism over the past thirty years has involved the development of numerous interventions and approaches. These efforts have led to the development of effective approaches that address the various difficulties faced by these individuals. However, reports suggest that the heterogeneous characteristics exhibited by autistic individuals limit the effectiveness of these approaches. The communication, social, and cognitive profiles of these individuals vary greatly, and there is no one-size-fits-all solution to the diverse difficulties they face. In the same vein, there is a scarcity of research that has focused on and accommodated the needs of the most vulnerable and underserved end of the spectrum, namely NV autistic children with little or no language (Pizzano, 2020).

A successful researcher's motivation to conduct a study is motivated by their deep interest in the field (Khine, 2018). Furthermore, a researcher will use learning from previous academic tenure in future research in order to develop new concepts and models (Zain et al., 2011). With this in mind, the current project grew out of my desire as a researcher to explore the different developmental milestones of autistic students and the lifelong challenges faced by them, specifically with regard to their SC difficulties.

Therefore, the focus of my research is to fill the gaps in knowledge related to NV autistic children and to investigate how recent technological resources can be adapted to facilitate their social and communication challenges. Another underlying motivation of this research is that the Saudi Ministry of Education has been executing various programmes for a long time in this domain, and many strategies and programmes have been articulated in this

setting in reaction to the increasing prevalence of autism and the integration of technological tools in educational settings. However, there is a lack of monitoring and assessment of the progress and development being made in students' improvement with the use of technology. There is very little publicly available evidence of evaluation at the governmental level; Allmnakrah and Evars (2020) assert that there was no evidence available on technology-enabled learning and development at the time they conducted their research, which was eight years after the execution of the *Tatweer* project of technology integration into Saudi schools. Hence, it is imperative to explore this area to properly evaluate the digital technology programmes in these schools for autistic students. The motivation to explore these insights further relates to the need to expand the existing research base on the use of technological devices by NV autistic students to manage and overcome their SC difficulties; this is a matter of priority and part of the Saudi educational policy pertaining to technology integration.

My goal as a researcher is to investigate how digital technologies, particularly tablet computers, commonly used in Saudi Arabian schools, can enhance social communication in NV autistic students. More specifically, it will focus on the major challenges of NV autistic students that are precursors to SC skills, i.e., joint attention, social engagement, and orientation (the three integral parts of social communication) (Adams et al., 2012). The research will serve as a foundational contribution to the knowledge base of future researchers and policymakers, offering valuable insights for the National Transformation Programme (NTP) and complementing the ongoing efforts for special needs students, including autistic students, in Saudi Vision 2030.

1.9. Research questions

This study aims to explore how digital technologies (tablets) are being used by teachers to support SC in NV autistic students in light of prior studies that highlight the affinity and engagement of autistic children with technological interfaces over any other medium, typically due to the ease and convenience that they offer relative to more traditional tools. Moreover, there is an observation that the proclivity of autistic children for the use of technology is shaped by their stereotypical interest in something and the ease of interaction and engagement that these tools offer through convenient features and multisensory elements for autistic children. The current study aimed to explore how teachers use digital technologies to enable SC skills, primarily joint attention and social engagement, and how these students use these digital technologies to exhibit their SC skills. Moreover, it aims to assess how these digital technologies provide communication and social opportunities for NV autistic students to interact with their mainstream peers.

Based on the background and purpose of the study, the following research questions have emerged:

RQ1: How do teachers use digital technologies to support the SC in NV autistic students?

In order to develop recommendations for school authorities, educational policymakers, and other pertinent bodies in KSA, it is important to explore the ways that teachers in Saudi schools incorporate digital technologies into the learning environment and examine the mechanism through which they help manage SC difficulties in NV autistic students. Although technology is used in multiple ways as a specialised intervention or to supplement instructions (Cabielles-Hernández et al., 2017), there is a dire need to explore how digital technologies are being used to enable SC skills in NV autistic students owing to existing gap for this particular group and use of modern interventions and tools for them. Moreover, it will also consider the role of other contextual factors that are relevant to teachers' use of digital technologies to support SC. The findings will contribute to determining potential technologies for this purpose, enabling their access, and facilitating their use in other contexts as well. To address this question, semi-structured interviews and the direct observation of classroom activities in which technology was used by NV autistic students were conducted to generate the relevant information.

RQ2: In what ways do NV autistic students use digital technology for SC?

Prior studies have determined how various augmentative and alternative communication devices serve as communication aids and a means of social interaction for autistic students (Gevarter et al., 2014). Most studies have identified the effectiveness of interventions and interactive sessions for verbal autistic students, but very little research has considered the use of digital technologies by NV autistic students to communicate, socially interact, and facilitate joint attention, social orienting, and other advanced SC skills. Moreover, this study will also examine the influence of other factors that may impact learning through digital technologies, for instance, motor skills. Other aspects to consider are the classroom structure, the facilities available to use digital technologies, the assistance provided by teachers to motivate the students, and their preference for using digital technologies to learn and support SC. Given the influence of these various aspects and the challenges and difficulties faced by NV autistic students, it is important to explore how they use digital technologies to exhibit SC skills and which specific features of technology are the most effective. Moreover, the research will also assess whether NV autistic students exercise SC skills voluntarily or only through enforced collaboration. This will determine whether

any gap exists in terms of further developments in technological facilities and availabilities. This question also has implications for determining whether NV autistic students use technology-mediated communication and social interactions in different ways.

RQ3: What are the factors contributing to the use of digital technologies as a positive learning tool for NV autistic students?

Valencia et al. (2019) have identified various positive contributions that the use of digital technologies makes to the learning skills and academic improvement of NV autistic students. Additionally, many studies have talked about the more advanced approaches and positive contributions of high-end technological set-ups, for example, virtual agents, artificial intelligence, and augmented reality, to enable a learning environment for autistic students. This directs attention towards the factors that positively contribute to or limit the effective learning and support of SC in NV autistic students. Assessing these factors is important, as prior research does not address the difficulties and learning challenges of NV autistic students. Producing information on this question will also help the authorities in KSA determine the effectiveness of their plans and programmes through the facilitative factors identified in this study.

RQ4: What are the barriers and challenges to using digital devices as a tool to support social communication in NV autistic students?

The integration of digital technology into the educational context globally is being recognised as a major advancement in academic settings. Technology, where it regulates the academic challenges for general and special education students, is also opening avenues of hope and opportunities for students with learning difficulties and neurodivergence (Reeve et al., 2022). The versatile options offer various educational possibilities that teachers can integrate into teaching practices; however, these benefits do not come alone but with various challenges and barriers from different dimensions. When technology is integrated with special education students, e.g., autistic students, as in the given study context, teachers, practitioners, and community members all have to be mindful of selecting the right options and facilities that provide an appropriate use of technology. It is important to recognise these challenges when we are dealing with individuals who have behavioural complications, too, and addressing their challenges when using a digital device can be difficult to determine, e.g., challenging behaviour and unexpected handling of the device (Kalembera and Majawa, 2015). The extent and nature of these challenges vary. Magen-Nagar and Maskit (2016) distinguish between technology-related barriers as individual or personal barriers, and institutional or organisational ones.

Therefore, considering this aspect is crucial when assessing digital technology's potential to support SC in NV autistic students, especially in light of current research.

1.10. Key Terms

This section provides the following descriptions to elucidate some of the terminology used and to enable a consistent understanding throughout the study

Social communication skills

In the context of the current study, the following areas are the focus of consideration as developmental precursors and catalysts to later dimensional skills: joint attention; social orientation; disposition to orient to social stimuli; seeking, wanting, and liking social contact; working to maintain social interactions (Marrus et al., 2017); motor imitation; and ToM (Lasch et al., 2023). Social communication in autistic children is behaviourally manifested through their preferential orientation to the social world, taking pleasure in social interactions, seeking out social exchanges, and working to foster and maintain social interactions and bonds (Stallworthy et al., 2023). The association between ToM and social communication has already been identified (Bamicha and Drigas, 2022); therefore, in this study, joint attention, social orientation, ToM, and social engagement are regarded as the key developmental precursors of SC.

Digital technologies

Andre et al. (2018) defined digital technologies as powerful instruments that comprise knowledge, skills, and know-how for the creation, processing, transmission, and use of digital data, as well as systems and procedures for practical implementation. Yu et al. (2022) further elucidate that digital technology encompasses the application of modern information and communication technology to gather, retain, evaluate, and disseminate physical information and market insights at every stage of the product value chain. This serves as a crucial technological foundation for fostering innovation across many domains. The plethora of digital technologies entails digital tools, software, and other gadgets, whether online or personal, that are employed to enhance the processes of learning, communication, teaching, and resource development (Keengwe, 2022).

Digital devices

Kuznekoff (2022) characterized digital devices as portable web-enabled electronic gadgets, such as smartphones, tablets, laptop computers, and smart watches. They are electronic devices that can receive, process, and send digital information, such as laptops, mobile phones, and tablets. The term broadly refers to a device or devices that function similarly to a computer but are typically more portable.

Hardware and Software

Computer hardware and software are integral components of modern technological systems. Typically, these two entities exhibit a complementary relationship, but they diverge in terms of their design and functionality (Duncan, 2017). Hardware encompasses all the physical components that constitute a computer system, including devices for input, output, processing, communication, and storage. Conversely, software denotes a collection of specific data, instructions, or programs that enable users to operate a computer and execute diverse tasks. Software is further classified as *system software* or *application software*, which are programs designed to do particular tasks on behalf of the user (Englander and Wong, 2021).

Tablets

Tablets are handheld touchscreen portable computer devices. The term "tablet" is often used to refer to a diverse range of devices that predominantly operate through touch screen interfaces. However, it is important to note that specifications might vary across different manufacturers. The iPad is a tablet device developed and manufactured by Apple Inc. The majority of tablet devices utilise Google’s Android operating system, but the iPad is powered by Apple’s iOS.

1.11. Organisation of the thesis

The thesis consists of six chapters, and a tabulated illustration of each chapter is shown in Figure 1. The following chapter, Chapter Two, is a literature review that contains a comprehensive evaluation of prior studies covering the autistic context, NV autistic students, and the use of digital technologies for autistic students. It continues with a review of the literature on SC in autistic students and different interventions used in prior studies. The chapter also covers the use of digital technologies in the Saudi context and

the identification of prevailing gaps in the research that the current thesis seeks to consider.

Chapter Three describes the research methodology. The qualitative multiple-case study approach was adopted to research three different school teachers' perceptions of and experience with the use of digital technology to manage SC difficulties in NV autistic children, through three different cases. A total of eleven teachers participated in the study; they all taught autistic students aged between 6 and 9 years old of primary level in three different schools. The chapter provides details of the data collection methods, i.e., semi-structured interviews with teachers as participants and the direct observation of classroom activities and teacher–student interaction. The data analysis method – thematic analysis (TA) and cross case analysis of themes – was incorporated to consider how digital technologies were utilised by teachers to support SC in NV autistic students, teachers' use of digital technologies with these students, how students are using these digital technologies to exhibit their SC skills, and what positive contributions teachers believe these digital technologies make to overall learning as well as teaching processes. This chapter further mentions the trustworthiness of the findings and also delineates the ethical considerations followed during the data collection process.

Chapter Four of the thesis is the findings chapter. It is an extensive chapter containing three different case studies and their findings obtained through semi-structured interviews with teachers and classroom observations of NV autistic students. The findings illustrate the different technological tools used in all three schools, the curriculum adopted and modified, and the various strategies and approaches adopted by the teachers to mediate the learning of NV students using digital technologies. The findings chapter further outlines the dimensions of effort, time, and experience in terms of teachers' perceptions of the use of technology and the challenges teachers face with effectively using digital technologies with these students. Following this, a cross-case analysis reflects on the similarities and differences identified through the themes identified in each case study, enabling the researcher to make distinctive points to ponder in the discussion chapter.

Chapter Five is the discussion of all three case studies. A critical assessment of the findings and arguments is made in light of prior studies pertinent to the research. This chapter also discusses how the findings of this research correspond with or produce new dimensions as a development point for future studies.

Chapter Six provides the conclusion of the thesis and discusses the contribution of findings in the given context. The conclusion chapter also presents the implications for future research and recommendations for practitioners and researchers. Moreover, Chapter Six

delineates the limitations of the present study and presents developmental points for future studies to take into consideration.

To provide a clear picture, Figure 1 presents a visual flowchart on how this thesis is organised.

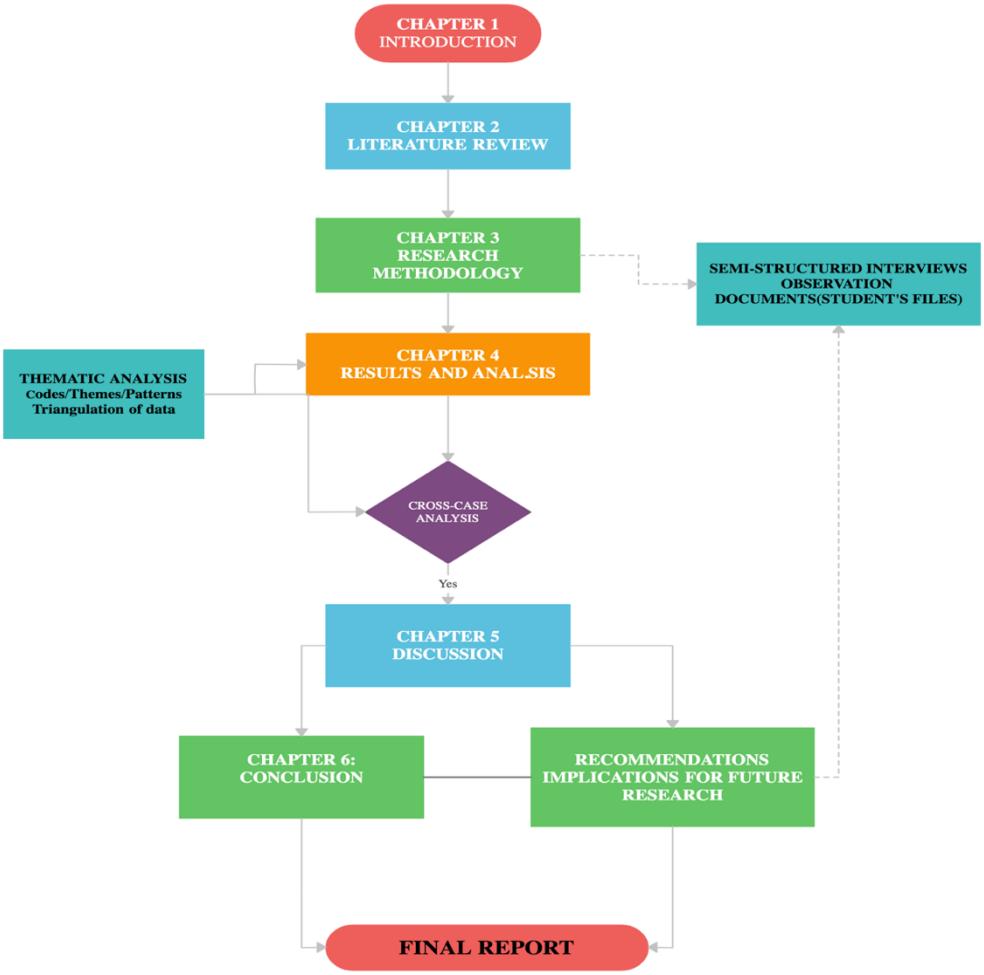


Figure 1 Organisation of thesis

The next chapter extensively reviews the existing literature in the context of NV autistic children and the difficulties faced by these students if their SC are left unaddressed. The role of digital technologies in supporting NV autistic students with SC is reviewed in light of prior studies. The perspectives highlighted in Chapter Two also develop a sound conceptual, theoretical perspective for the current study.

Chapter Two: Literature Review

2.0. Overview

This chapter discusses the pertinent literature assessing the role of digital technologies in supporting SC in NV autistic students in the Saudi Arabian context. It further assesses the gaps and challenges in the existing literature on using digital technologies for NV autistic students, as well as conducting a critical analysis and evaluation of the findings from prior studies related to the research questions. It reviews the literature on NV autistic students, SC skills and challenges, the pertinent precursors to SC, interventions and strategies used to address SC difficulties, the use of digital technologies in addressing these difficulties, and the role of teachers in the efficient use of technology. It also reviews the literature on the effectiveness of traditional interventions vs. digital devices, teachers' preferences to use traditional or digital interventions, the role of teacher-directed instructions, and how these contribute to supporting SC skills. The current investigation justifies the use of the mainstream school setting in Saudi Arabia and identifies prior findings in this context. This chapter finally investigates the many contributing factors and challenges that play an influential role in the effective use of digital devices to support SC, particularly technical, administrative, and training support.

The underlying study also reflects on the theoretical underpinnings of the research, including social constructivist theory and Vygotsky's theories of learning, i.e., Zone of Proximal Development (ZPD), scaffolding, and the role of a More Knowledgeable Other (MKO). A substantial body of past studies supports the effectiveness of digital devices along with traditional interventions for managing SC skills in NV autistic students (Kane et al., 2010; Lane et al., 2016) and the generalisation and maintenance of newly learned skills (Schreibman et al., 2015). However, there remain gaps in the literature, specifically regarding adequate research and supportive findings on the use of digital technology for NV autistic students in Saudi Arabia. Moreover, another identified gap concerns the challenges and contributing factors that impede the effective implementation of digital technologies in Saudi Arabia, particularly for NV autistic students and managing their challenges. In the context of social constructivism and looking at how different social factors affect managing NV autistic students, this study also looks at how different psychological and social factors affect the choice and use of digital technologies to enable SC in these students (Alomary and Woolard, 2015).

The following section will highlight the theoretical underpinning of the study, which will address the research questions of how digital technologies can support SC in NV autistic students.

2.1. Theoretical framework

The theoretical construct of research reflects the overall path of the research to give a more meaningful approach to the research and make the findings more effective (Zlatkin-Troitschanskaia et al., 2018). Similarly, to have a profound theoretical basis, the use of one theory is not enough to adequately confirm the findings and address the research questions (Ravitch and Riggan, 2016). Therefore, Grant and Osanloo (2014) recommend integrating multiple theories to fully answer the research questions and gain a comprehensive understanding of the research phenomenon. The choice of these particular theories was based primarily on research literature that identifies similar theoretical contexts for the issues being examined as "multi-layered and complex" (Ravitch and Riggan, 2016, p. 12), which means finding applicable theories that "clarify the why and the how" (Ravitch and Riggan, 2016, p. 13). The theories that inform this research and situate the data in a context or framework are Social Constructivism Theory (Vygotsky, 1962), Cognitive Development Theory (Vygotsky, 1971) and the concepts of scaffolding, Zone of Proximal Development (ZPD), and more knowledgeable others (MKO). The combined use of these theories and concepts will provide a useful theoretical framework to help explore how the factors contributing to SC difficulties can be overcome using digital technology and how technology will serve as a mediator in facilitating SC in NV autistic children. The essence of the theoretical framework is provided through communication skills, the role that social constructivists can play in supporting social interaction and the central context for learning, and Vygotsky's Theory of Cognitive Development. Vygotsky's theory is focused on social learning and the ZPD, considering the role of an MKO as a mediator in the language and social learning process through the use of technology and the guidance of the teacher as a caregiver to help improve their joint attention, social orientation, and theory of mind. The following explanation of relevant theories and models will provide a background for the investigation of this study.

The section will explore how SC is managed in light of social constructivist theory and how it relates to NV autistic students.

2.1.1. Social constructivist theory

According to Bednar et al. (1995), it is imperative that instructional techniques and instruments used for developing skills and addressing challenges are grounded in a

theoretical framework of learning and cognition. Certainly, the process of formulating convincing perspectives that effectively address the fundamental epistemological questions pertaining to human cognition has been a subject of scholarly interest among psychologists and educators throughout an extended period of time. In line with this opinion, the current study aligns with the social constructivist theory of learning as the former finds that collaborative and interactive orientation of learning in children has significant implications within a social context (Gallagher et al., 2015; Kiraly, 2014).

The modern research base has been evolving with regard to determining the link between social constructivist theory and the integration of technological tools and applications in the domain of effective pedagogical applications and practices. Several researchers have examined this relationship between constructivist learning and digital technologies in the contexts of computer-mediated learning settings (Woo and Reeves, 2007; Mohd et al., 2020) and blended learning (Heinze and Procter, 2006), and some have assessed it in the context of social media software and websites (McLoughlin and Lee, 2007). The concept of constructivism, coined by Bruner (1960) and then further elaborated by Vygotsky (1978), elucidates how individuals interact socially; it points towards the notion of the co-construction of knowledge in a social environment. The researchers discussed the importance of language as a central element in the social constructivist perspective of the learning process. They further elaborated on the co-construction of knowledge, by discussing the use and role of language as an inter-psychological tool of meaning construction in a social interaction process.

Marsh and Ketterer (2005) have elaborated on the notion of learning by Vygotsky (1978) i.e., effective learning leads to the development of an internal dialogue as a memory for an individual. This serves as an intra-psychological tool to develop their ability to communicate, make sense of their surrounding environment and perform appropriately in different situations in future. However, this concept also identifies the need to know the distinction between knowledge and learning. To understand this distinction, Vygotsky's (1978) view of the social constructivist perspective elucidates that knowledge is the co-construction (inter-psychologically) of ideas with others in an environment. On the other hand, learning that is an internal mechanism, happening inter-psychologically in an individual, may also occur through collaboration. Hence, learning is result of knowledge and it occurs at an individual level through interaction and knowledge co-created in a context. On this basis, John-Steiner and Mahn (1996) suggest that the internalisation of information occurs in both aspects i.e., individual as well as social processes. Considering Vygotsky's viewpoint that the "learning of individuals [is] shaped by social processes and the context in which they grow into the intellects of those surrounding them" (1978; p,

88), the role of digital technologies in a learning and pedagogical process becomes more evident. However, despite the versatile nature and varieties of any digital tool, it is important to understand that these tools are not a replacement for instructions and traditional learning methods, nor they can be a remedy for all conventional and questionable teaching methods.

Given that autistic individuals are limited by their difficulties in social interactions, joint attention, and communication, they exhibit limitations and face challenges in a general education setting; hence, they lag behind in their understanding of classroom instructions and improvement of pertinent skills, including SC skills. This highlights the need for teachers to employ a constructivist approach to help the child develop skills (APA, 2013). Pertinent to their learning needs, Gallagher et al. (2015) underlines the potential need for communication development in autistic students to perform well academically, as well as development in their social reciprocity. Therefore, the current study connects two theories to investigate teachers' integration of digital technology and tools into learning to facilitate a constructivist and interactive learning through their instructions and to improve the developmental trajectory of these students.

Prior researchers have suggested that the idea postulated by constructivist theory as a learning philosophy should be applied as an instructional strategy for autistic students (Lopez, 2015; Weimer et al., 2017). The theoretical assumptions by Bruner (1996), Vygotsky (1978), and Piaget (1973) point towards the tendency to engage in active learning and new knowledge construction through social interaction (Churcher, 2014). Another important perspective to be mentioned here, as recognised by Boser and Abowd (2013), is the internalisation of knowledge in an individual, which serves the purpose of activating knowledge to motivate further learning. The ability of autistic children to utter limited expressive words relates to that internalised knowledge, which comes from either home-based training or learning or sometimes their pre-school learning. Moreover, this internalisation of knowledge, as mentioned by Chen et al. (2010), also comes from the context and environment they are surrounded by or living in. Adding to this, Andrews (2012) further explains that a learners' internalisation and development of beliefs and understanding are achieved through the people around them. This makes it clearer that a social setting and a given context have an effect on how autistic children learn and develop their communication and social skills. The importance of contextual factors and setting has been stressed by prior evidence showing that it is relevant and mandatory for teachers and practitioners to consider the contextual factors that may mediate the learning in autistic students.

Guler et al. (2018) identified multiple contextual factors that may impact the actual development of targeted skills in autistic students: the affordability of interventions and tools; language; location (individualised segregated classrooms or general education setting); teacher's skills and required support; parenting practices at home. Therefore, the best way to adapt is to use the teacher's preferred contextual route that fits with how the student learns and what the teacher knows. Therefore, it is advantageous if the learning takes place under the guidance of a proficient teacher who employs strategies and interventions pertinent to the context in order to motivate their expressive and receptive language. This lays the basis for how a social constructivist context, i.e., a classroom under the guidance of a teacher, with the use of the right instructions and strategies, lays the foundation for improving SC skills in autistic individuals (Asaro-Saddler et al., 2017).

In order to facilitate SC enhancement in autistic students, other relevant aspects also need consideration, as elaborated below. The following section explains the theory of language development through the theoretical lens of ZPD by Vygotsky.

2.1.2. Role of ZPD and scaffolding

Vygotsky postulated that the ZPD represents the distance between an individual's current level of development and their potential level of development (Vygotsky, 1978). This discrepancy is influenced by the extent to which individuals engage in autonomous problem-solving vs problem solving with the assistance of an expert (Vygotsky, 1978). Rizzo et al. (2012) elaborated on the concept of ZPD in the context of technologically mediated learning. The authors mention that Vygotsky's (1978) conception of ZPD provides a useful insight into this dynamic process of social and collaborative learning. ZPD entails the distinction of what a child is capable of doing himself and what they can accomplish with help of others who are more capable. The application of this concept to the use of digital technologies and mediation provides an overall learning process where a participant is exposed to them under the guidance of a skilled facilitator. Through this guided interaction, children are encouraged to learn and develop skills that they were not able to accomplish independently on their own. Therefore, the role of the MKO is crucial to the overall learning and development of child, whether through digitally mediated learning or conventional learning (Luckin et al., 2012). Considering the context of the current study, it is important to mention the role of MKO in the use of digital tools. Mancher (2018) elaborates that the role of an adult facilitator and their supervision makes its independent contribution to the overall engagement, learning and development of a child. For instance, if the facilitator teachers and parents have a positive view of technological tools, this would direct them to facilitate and provide technologically based assistance,

selection and execution in different settings for the child's learning. Contrary to this, if teachers and parents as MKOs are passive towards the use of technology, this would lead to a limited or constrained use of technology (Plowman, 2016). In addition to the role of technology as a mediator of learning, there is evidence for the inbuilt features and functions of technology that scaffold and influence the child's learning, collaboration and social development with use of these tools (Bekker et al., 2010).

Similar to this is the concept of scaffolding, where a competent tutor or peer supports the learning process in the ZPD of the learner (Wood et al., 1976). More precisely, scaffolding refers to how an expert adult directs learning through positive interaction and focused intervening, thus deeming social interaction crucial in language development. Well (1999) highlights scaffolding as a means of operationalising the ZPD and further corroborates three important characteristics for scaffolding to be successful: it should aim to construct knowledge through dialogue; endorse collaborative activity to embed knowledge; and be a potential artefact that mediates learning and knowledge (Khaliliaqdam, 2014). From the perspective discussed above, the underlying study will explore how teachers use digital technologies to enable NV autistic students' SC through the teacher's support.

In light of the abovementioned theoretical underpinning, the current study explores the role of digital technologies in facilitating joint attention, social orientation, social interaction, and ToM, to see if they help NV autistic students with their SC challenges. Allen et al. (2016) emphasise that in order to facilitate communication and social skills and to avoid the self-contained nature of tablets, expert collaboration, either through tutors or parents, is imperative. This is linked to Vygotsky's view of MKOs directing learning processes through scaffolding. As in early interventions of SC, where a specific sequence is followed by teachers to help learners develop language and social cognition, technologies also require a set of instructions and tutor guidance for better exposure to language development approaches (Wodka et al., 2013). Prior research in a similar context supports the view that appropriate training and guidance from teachers may direct NV autistic children towards better social and communication skills (Xin and Leonard, 2015; Fletcher-Watson et al., 2016).

Ayers et al. (2013) posit that, generally, technology is not exclusive to any tool or intervention, but that its real potential is how it will be used. So, this study's most notable theoretical connotation follows Vygotsky's view of learning, where technological opportunities are rendered as contributing to SC, specifically in the domains of joint attention, social orientation and ToM through interactive technological activities. The development of joint attention and joint action, especially in the context of social interactive settings, provides rich opportunities for describing the characteristics of

interactions that can lead to shared outcomes. In the present research, I argue that technologically mediated interactions can benefit from these developmental studies, by influencing an individual's perception and interpretation of the role of digital technologies. I thus endeavour to describe some components that could be integrated into digital devices to strengthen their role in supporting SC and thus improve the success of collaborative tasks.

In this research, in light of Vygotsky's concepts of MKO, ZPD, and scaffolding, we will determine how digital technological can be supportive tools to support SC in a classroom setting, keeping in mind the research questions of the underlying study.

2.1.3. Vygotsky's theory of language development and ZPD

The principal concept of Vygotsky's theoretical framework is that social interaction plays a vital role in the development of cognition (Amineh and Asl, 2015). Vygotsky's multifaceted cognitive development theory establishes that cognitive development varies across cultures. Socially mediated processes leading to social interactions influence an individual's cognitive development through learning at various points of interaction. Prior evidence has demonstrated that Vygotsky's theoretical formulations are promising in terms of developing a learning medium through the role of an expert guide who efficiently engages a child and then balances their autonomy through mediation and scaffolding. In order to enhance the social and communication profile of autistic children, a teacher's role includes the mediation of skills, paired with scaffolding efforts for skill use, aiming to increase social interaction with peers as well as demonstrating the use of targeted social skills.

Vygotsky's language development perspective stresses the role of language development in overall cognitive development and it argues that it is not isolated from external social processes; thus, any language development must go through external social aspects before becoming internal (Jones, 2009). Considering language as a crucial tool for communication with the outer world, Vygotsky (1978) further stresses language development as a process of social interaction specifically for communication purposes. Any aspect or function is primarily social, and on becoming internal, the function is termed 'internalisation'. He further identified three distinctive forms of language. There is social speech, which is used to communicate externally to others and manifests at the age of two years, and private speech, which is manifested at the age of three and is intellectually linked to self-direction and social speech is concealed over time to diminished auditory speech. The third type is controlled through the self-regulation function and it is identified as silent inner speech (manifested at the age of seven years). Vygotsky (1978) explains the internalisation of speech as a progressive process, i.e., he argues that since the

beginning of an individual's life, thought and language are independent systems that come into contact at the age of three years and become interdependent; thoughts takes the form of verbal behaviour and speech appears as representational. This is followed by the internalisation of monologues by children as their inner speech. Imperative to this concept is the perspective of inter-subjectivity (Rommetveit, 1985; Wertsch, 1998) that pertains to mediation and mutual understanding between a learner and their expert co-partner. The mediating role is played by a facilitator termed the More Knowledgeable Other (MKO). This can be a professional, teacher, or parent, and they are deemed to be influential in terms of knowledge and skill acquisition by Vygotsky (1978). The presence of the MKO then directs the further vertical process of knowledge transfer to develop the child's area of potential learning, rendered as a ZPD by directing the learning process through scaffolding (McLeod, 2014).

According to Vygotsky (1978), individuals with learning difficulties have the propensity to improve from their actual developmental level to the desired level of development through 'scaffolding', if enough interaction with the expert person, i.e., MKO, is provided. Based on constructivist learning theory, learning and development combine in a social process that serves as an intervention for language acquisition. Within this view, a learner executes a task more efficiently with the support of another, compared to having no assistance. Thus, in order to advance learning skills, it is crucial to collaborate with an expert guide who will guide the student to accomplish their ZPD through scaffolding.

The following section reflect on overview of autism:

2.2. Overview of Autism

Rates of autism are thought to have rapidly increased globally over the past 30 years, and the current prevalence has been estimated in a recent review to be at least 1.5% in developed countries (Lyall et al., 2017). Despite persistent heterogeneity in the methodologies used in different studies, there has been an evident common trend of an increase over time in prevalence (Fombonne, 2018). The literature about autism traces its lineage back to 1943, identified by Dr. Kanner (1965) as a unique neurodevelopmental issue termed infantile autism, Kanner syndrome, and later childhood autism (Al-Jadiry and Al-Jadiri, 2019). It was identified as a combination of characteristics such as isolated behaviour at a young age, repetitive patterns of behaviour, and language impairments. Following this characterisation, Wing and Gould (1979) further explained the autistic condition as a collection of neurodevelopmental difficulties recognised mainly by impairment in SC, interactions, and stereotypical behaviour and interests (APA, 2013).

Later, the formalised development of reliable and calibrated diagnostic criteria, i.e., the Diagnostic and Statistical Manual (DSM), gave a more useful diagnosis of autistic characteristics in each subsequent revision.

The first inclusion of autism was marked in DSM-II (1952) as a form of childhood schizophrenia, followed by its modification in DSM-III (1980) as "Pervasive Developmental Disorder (PDD) distinct from schizophrenia". Later, DSM-III revised the criteria to DSM-III-R and broadened the concept of autistic challenges as Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS) and delineated autistic characteristics officially as a spectrum of disorders rather than a single disorder in DSM-IV (1994). This edition included five distinct disorders – Autistic Disorder, Asperger's Disorder, Childhood Disintegrative Disorder, Rett's Syndrome, and Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS) – with their own distinct genetic origin. The most current calibration, i.e., DSM-V, presented a new and more persistent conceptualisation of autistic individuals, i.e., they should exhibit traits since early childhood, even though the characteristics may not be recognised until they are older (American Psychiatric Association APA, 2013). According to the DSM-V standardised criteria, autism is recognised as dimensional rather than a distinct disorder, designating a two-factor model of autistic individuals, present in them since early childhood, i.e., "persistent impairment in their reciprocal SC and social interaction across multiple contexts" and "stereotypical repetitive behavioural patterns".

Also, this edition dropped AD, PDD-NOS, Rett's syndrome, and CDD from the criteria, as these had raised concerns among people previously diagnosed with these excluded disorders. DSM-V further elucidates that one of the core challenges in autistic individuals is social-emotional reciprocity and impaired social behaviour. For example, they can experience difficulty in understanding gestures and hence lack a comprehensive use and understanding of NV behaviour, additionally identified by their preference for isolation, reduced sharing of interests and emotions, and failure to initiate as well as respond to social interactions.

Correspondingly, the difficulties in NV communication behaviours needed for effective social interaction are reflected in behaviours such as poor gaze and body language, ineffective use of appropriate gestures, repetitive behaviours such as flapping of hands, tapping a surface, staring for a long time, a prolonged focus on something, or a total inability to exhibit facial expressions and NV communication.

2.2.1. Non-verbal NV/minimally verbal MV autistic individuals

Despite the increasing awareness and advancement in educational programmes for autistic children, relatively few studies exist in the context of minimally and non-verbal autistic children (Koegel et al., 2020). Researchers highlight that this group, which is under-represented in research, makes up to one-third of the autistic population (Koegel et al., 2019; Tager-Flusberg and Kasari, 2013). Another viewpoint on this autistic phenotype is that 50% of these children may remain NV throughout their lifespan despite being provided with interventions (Prizant, 1983). The linguistic tendencies in autistic individuals vary from fluent speech to average verbal proficiency to minimally verbal or NV (Sullivan et al., 2019). NV autistic individuals are those who cannot produce more than 20 functional spoken or augmented words at pre-school age (Tager-Flusberg and Kasari, 2013), and the term covers children of school age and older (Plesa-Skwerer et al., 2016). However, the effectiveness and novelty of an intervention may direct autistic children to learn expressive verbal communication if applied in the early years before the age of five (Anderson, 2007).

The formal definition of this subgroup focuses mainly on expressive language (Kasari et al., 2013); some may tend to utter a few fixed phrases, some may offer spontaneous speech, and others just a few dozen words. In addition to variability in expressive language, there is also variation in the receptive language skills of NV individuals; some appear to comprehend more than a few words and others may reveal comprehension of only a few limited words or phrases. Plesa-Skwerer et al. (2016) define preschool NV children as those whose expressive language scores are below the prescribed standard at 12 months and who utter less than 10 comprehensible spoken words, with a few using no functional or understandable spoken words. Despite these factors, it is still difficult to determine with certainty whether an individual is just preverbal (i.e., has language delay but may develop spoken language later) or is more likely to remain NV (does not use spoken language and may not in the future) (Kasari et al., 2014).

Limited evidence is available about these individuals owing to the great variation of characteristics and patterns of skills they exhibit (Almirall et al., 2016); this gap is further widened by the lack of reliable and valid assessments of the developmental trajectory of such individuals (Bal et al., 2016; Thurm et al., 2015). The primary reason for the lack of evidence from prior research on this neglected end of the spectrum is the fact that it is potentially challenging to complete assessments with these individuals (Bal et al., 2016), and to determine interventions to address the alterations and impairments experienced by NV autistic children (Wodka et al., 2013). As a result, the majority of research focuses on autistic children with moderate SC difficulties (Tager-Flusberg and Kasari, 2014), and generalising findings from these studies for minimally or NV autistic children is

controversial owing to the variance in their difficulty level and responsiveness to interventions in a given context.

Considering their communication and social profile, and their inability to maintain joint attention, gaze, and engagement, Rose et al. (2016) proposed that MV/NV individuals require individualised and complementary attention and support to initiate, retain, and continue their communication. Categorising children with limited spontaneous functional words as 'NV' omits the fact that they may produce some words. However, these words are restricted, repetitive, and echoed, and involve some vowel approximations and scripted words that impede their overall communicative function (Bal et al., 2016; Shire et al., 2014). It is widely accepted that autistic characteristics are difficult to evaluate, and MV individuals exhibit a whole range of challenging and atypical behaviour (Tager-Flusberg and Dominick, 2011).

In order to assess the distinctive features of NV autistic students, it is important to understand the delays in their receptive and expressive language. Pickles et al. (2014) explain that variation is related to their ability and the pace at which their language develops. On the other hand, others may face persistent limitations in the development of their language profile. Another context focuses on the internalisation of knowledge and the learning environment of the individual, as social constructivist theorists consider this perspective fundamental to the activation of knowledge and its preceding skills and learning (Boser and Abowd, 2013). Internalisation of information or knowledge in a social context is a key concept in cognitive development (Murphy, 2022).

To understand this, it is crucial to refer to the concept of internalisation and language development put forward by Vygotsky (1981). This emphasises the important role of language in a learner's internalisation of key concepts and knowledge. For example, in a classroom context, the teacher introduces a learner to different words and terms that are referred to as outer speech, which are then used by the students. In this process, those words become internalised and referred to as inner speech; they further develop students' understanding, concepts, and knowledge so that they can develop them as independent learners. Therefore, for MV/NV autistic students, the utterance of a few expressive words is connected to their internalised knowledge that they may have learned during their pre-school period or through any other social context, i.e., home.

Cheng and Ye (2010) further added that children's learning and communication abilities are motivated by the situations or settings in which they live and work. Likewise, Andrews (2012) explains that the beliefs, understanding, and interpretation of learners are shaped significantly by their surroundings and environment. Hence, linking this to autistic

students, they are more likely to learn and develop communication skills in a social setting in the presence of a proficient instructor who can encourage their expressive and receptive language through the use of strategies and interventions. Hence, a socially constructivist classroom setting, accompanied by the use of the right instructions and interventions, lays the foundation for improving SC skills in autistic individuals (Asaro-Saddler et al., 2017).

Magiati et al. (2014) elucidate that despite access to interventions and therapies, many NV individuals fail to develop linguistic abilities. Alongside this, there are children who may acquire language slowly during their preschool years, and by school age, they may be able to utter a few words and phrases. Kasari et al. (2013) characterise NV autistic children as individuals with a minimal repertoire of spoken words and fixed communication phrases. The downstream consequences of a lack of support to improve language skills include NV autistic students developing behavioural problems, social isolation, and impeded academic success (Tager-Flusberg and Kasari, 2014). The inability to use language functionally and socially, as per the prescribed standards, means that MV autistic children are slow communicators (Shire et al., 2015).

Shire et al. (2015) highlight empirical evidence from limited prior research that uses various SC interventions for MV/NV autistic individuals and they identified an improvement in spontaneous SC skills, as several NV students exhibited functional spoken words between the ages of five and thirteen (Pickett et al., 2009). Similarly, Paul et al. (2013) noted improvement in NV core skills through the use of controlled language interventions and improvements in SC difficulties. Thus, altogether these findings reveal the proclivity of improving SC skills in MV/NV autistic individuals.

The next section will expand on how SC difficulties pose challenges for autistic individuals with regard to developing better social exchange relationships and effective pragmatics to develop a better communication profile.

2.3. Social communication difficulties

SC difficulties have been described as one of the prominent challenges in autistic children (Watkins et al., 2017) and the investigation of social communication issues holds significance in the field of autism research due to its consequences in the domains of social and emotional functioning. It is also recognised as one of the criteria for the diagnosis of traits exhibited by autistic individuals under DSM-5 (APA, 2013). Diagnosis, according to DSM-5, accurately demarcates individuals who have prominent problems with the use of verbal or NV SC skills, which results in them developing an inability to maintain effective communication, social participation, and social relationships (Levin et al., 2015). According

to DSM-V, SC challenges in autistic children are characterised by difficulties in social-emotional exchanges (exchange and reciprocity of emotions, interests, and conversation), and difficulties with socialisation, further limiting the communication skills development of autistic individuals. Further challenges include difficulties in NV communication behaviours such as maintaining appropriate eye contact, making appropriate gestures, facial expressions, and body language, and difficulties with establishing social relationships and interactions (developing networks and friendships, imaginative play). Also, some studies attributed this change in definitional construct to the evolution of dimensional perspective and being part of a neurodiversity continuum rather than a disorder (Lyall et al., 2017). Pertinent to this fact, it is of considerable importance to know these variations in characteristics, to consider multifaceted issues as they have implications for overall learning, and to devise solutions that help autistic children to grow academically in line with their typically developing peers.

SC is an 'umbrella term', as described by Kossyvaki and Curran (2020, p.7), that considers both social interaction and communication skills. According to Mundy et al. (1986), social communication may be generally defined as the process of exchanging information, opinions, or ideas amongst individuals. The primary characteristic of this definition is its emphasis on deliberate communication directed towards another individual, exceeding mere spoken language skills and encompassing NV forms of communication such as gestures and eye contact. The establishment of SC plays a crucial role in the initiation of joint attention, behavioural regulation, and active participation in social interactions and it is considered a foundational element for expressive language acquisition in autistic children.

Prior literature has talked at length about the natural overlap that exists between communication and social interaction (Fuller and Kaiser, 2020) and this was also recognised and discussed by the DSM-V. Dijkstra and Gest (2015) explained social interaction as the reciprocal exchange of information, which also entails relational aspects, including friendships, acceptance, and belonging (Winstead and Derlega, 1986). On the other hand, communication as an important dimension of SC is an interactive process that entails information exchange between involved individuals that involves body language, speech, facial expressions, and gestures (Rogoff, 1990). Irrespective of the diverse range of experiences and attributes that exists among autistic individuals, there is a consistent presence of SC difficulties (Lord et al., 2015; APA, 2013), specifically in areas such as social-emotional reciprocity, NV communication and the development of social relationships (APA, 2013). More defined traits of SC difficulties include an inappropriate use of verbal initiations that inhibit the conversation (Levin et al., 2015; Martin et al.,

2018), which further adds to social isolation and limits the conversational practices and space for improvement of expressive language (Fletcher-Watson et al., 2016).

Distinguishing characteristics of SC difficulties become evident in early infancy, encompassing difficulties with initiating and responding to joint attention, as well as disparities in comprehending NV communication such as eye contact, imitation, body language, gestures, and facial expression. These observations have been supported by various studies (Zwaigenbaum et al., 2013; Chawarska et al., 2016; Franchini et al., 2017). The aforementioned disparities often become more apparent among school-aged children diagnosed as autistic as a result of enhanced social expectations (Einfeld et al., 2018), particularly in relation to interactions with peers. An understanding of the defining features of SC skills is required in order to provide the appropriate assessments and support to address SC challenges in autistic children (Loukusa et al., 2018). SC attributes include the tendency to use language and to develop communication interpersonally in appropriate ways to interpret events and influence people (Brukner-Wertman et al., 2016), where the underlying component further contributes to social interaction, language processing, and development (i.e., appropriate use of language as per the given context) (DSM-5).

Depending on their SC challenges and repetitive patterns of behaviour, the persistent challenges faced by autistic individuals may be rated at different levels between individuals in terms of their severity, functionality, and the variations in the severity of characteristics. Consequently, their learning capacities and choice of interventions that will work for them also vary (Mehling and Tasse, 2016). Level 1, being the lowest in severity, requires basic support but limitations are obvious due to communication problems and there is also a difficulty with switching from one behaviour to another. Level 2, needing substantial support, exhibits obvious communication impairment and behavioural challenges that impede learning and other functions despite the provision of support. Level 3, requiring the 'most substantial support', describes the very limited functioning of these individuals in different domains of life, including behavioural complications (Lobban-Shymko et al., 2017). varying levels of autistic functionality, and variations in the severity of characteristics from individual to individual (APA, 2013). Due to SC challenges, autistic children are further constrained in terms of social–emotional reciprocity, and the communicative behaviour required to establish, understand and maintain social interactions and relationships. Considering the variety of impact that SC challenges have, the development of effective intervention has long been the focus of research (Watkins et al., 2015). Sanchak and Thomas (2016) discuss how the span of impact of these SC difficulties ranges from a normal back and forth interaction and conversation, limited

sharing of interests, to a failure to retain social interaction. Watkins et al. (2017) detailed that these are further accompanied by other challenges such as ineffective eye context, facial expressions, body language, and the correct use of gestures in a situation.

Krstovska-Guerrero and Jones (2016) stated that numerous difficulties are exhibited by autistic children in the early days of infancy in their basic SC interactions (e.g., impairment in eye gaze in the domain of joint attention, requesting something, and initiating any interaction), even before any diagnosis is conducted. Also, these fundamental skills are the foundation of more complex abilities in autistic children, i.e., language and social skills (Hampton and Kaiser, 2016; Bradshaw et al., 2018). Thus, determining timely and effective interventions is the way to alleviate the more severe characteristics and prevent them from developing (Zwaigenbaum et al., 2015; Gates et al., 2017). This also enables the development of their SC, which is imperative for their overall learning and academic growth (Krstovska-Guerrero and Jones, 2016). SC difficulties are exhibited by both highly verbal and NV autistic individuals, becoming apparent in early childhood and preventing them from participating fully in social and work domains (Delehanty et al., 2018). Furthermore, both verbal and NV autistic individuals exhibit SC difficulties where they encounter problems with social interactions, social understanding, and the appropriate use of language (pragmatics) (DSM-V, 2013; Grzadzinski et al., 2013). The Social Communication Questionnaire (SCQ) (Rutter et al., 2003) is widely employed as a primary tool for screening autistic children in the domain of SC and it is sometimes used in combination with other measures such as the Autism Diagnostic Observation Schedule (ADOS) and the Autism Diagnostic Interview—Revised (ADI-R) (Chesnut et al., 2017).

Theoretically, a number of early SC abilities are crucial for later, more complex social behaviours (Hansen et al., 2018). Each aspect of SC has some theoretical perspective that further affects the factors affecting the development of each (Fakhoury, 2015). For example, those exhibiting difficulties with pragmatics are found to have problems with turn-taking communication to maintain conversations or respond to queries (Vaiouli et al., 2015). Correspondingly, these various components of SC are found to have heterogeneous and complex aetiologies (Brukner-Wertman et al., 2016), as autistic individuals with these difficulties are found to struggle with participation in conversation and social interactions. The development and improvement in SC skills is also found to be associated with the primary developmental covariates including responsiveness to joint attention (Krstovska-Guerrero and Jones,2016); social orientation (Zheng et al., 2016); social interaction (Bottema-Beutel, 2017); and ToM (Brock et al., 2022). Theory of Mind (ToM) is linked to fundamental social, emotional, and cognitive abilities, particularly in the domain of verbal ability, encompassing both receptive and expressive language. Additionally, ToM is also

associated with the understanding of emotions, as highlighted by Brock et al. (2018). Further explaining this interlinkage, Crosse et al. (2022) specify that for communication and social behaviour, auditory and visual senses are interacting, and while interacting in a given context, these senses should work together, such as listening to the voice and watching facial expressions and lip movements for effective multisensory integration.

Joint attention is one of the hallmarks of early SC difficulties in autistic students and it is manifested as inappropriate eye gaze, eye shift and gestures – these are characteristics of joint attention (Zwaigenbaum et al., 2013; Krstovska-Guerrero and Jones, 2015) that contribute to difficulty and failure in interactions in progressive ages. In the early school years, the joint attention difficulties and differences are striking characteristics that later account for the delayed development of expressive language (Hampton et al., 2021). Hence, evidence from prior research suggests that early-age interventions prioritise improvement in joint attention (e.g., gaze alteration and gestures) as it serves as a mediator in subsequent expressive language, motor skills and overall social interaction (Muzammal and Jones, 2017; Bruyneel et al., 2019).

Fuller and Kaiser (2020) mentioned that addressing joint attention and engagement produces meaningful improvements in the social and communication profiles of autistic children. For instance, a shared experience is accomplished, and when the ability to engage in joint attention is developed, this facilitates language learning through the joint focus of attention to words (learning content) (Kaiser and Hampton, 2017). Kaiser and Trent (2007) proposed that early SC skills are said to be determinants of multiple cognitive, social and learning (literacy) skills that relate to students' academic readiness and accomplishments (McLelland and Morrison, 2003). A strong relationship exists between SC challenges and the behavioural complications exhibited by autistic children according to existing studies (Matson, 2007). Kaiser and Trent (2007) further reflect on how these SC difficulties impact on meaningful social interaction in that they limit autistic children's engagement with their peers, which may further limit their learning and growth in a given natural context (e.g., school). Keeping this in mind, there are substantial propositions that support the execution of interventions at an early age as these can be effective in teaching SC skills to young autistic children (Reichow et al., 2010). The efficacy of early intervention is higher (Lane et al., 2016) as it may assist children to overcome the challenges of social interactions and to generalise and retain the newly developed SC skills. If left unaddressed for long, the difficulties may delay the development of social interaction skills and further adaptive behavioural, daily living, and academic skills.

Another SC specifier, social interaction, has underpinning developmental precursors that control individuals' development (Adam et al., 2012). Social interaction are functions of

language and are mediated by the language abilities of individuals, including NV cues, inference, emotion regulation, and perspective taking. Most obvious in the early developmental stages is the social interaction difficulties that lead to further challenges in pragmatics and language processing (Westby, 2014). Language processing determines the ability of an autistic individual to produce and comprehend language, and to engage in active listening to comprehend and sequence the interaction discourse; this further leads to competence in grammar and semantics (Adams, 2014). The limitations in language processing determine the limitations of larger communicative contexts (Adams et al., 2012). Hence, addressing these limitations as a whole can help to achieve overall improvements in SC skills. The lack of coherence due to various difficulties such as lack of joint attention (Fletcher-Watson et al., 2015), social orientation/ToM, and social interaction, as reported by existing researchers, will be considered by the current research as focus features for regulating SC difficulties and as developmental precursors of SC in autistic individuals (Fakhoury, 2015; Fletcher-Watson et al., 2015).

The successful development of these precursors of SC skills is imperative for the effective functioning of autistic students; therefore, addressing the underlying challenges to these components will contribute to the overall communicative and social abilities of the individual. According to Bedford et al. (2014), different developmental precursors are important for improving SC skills in autistic individuals. The following section will elaborate on these.

2.4. Developmental precursors of SC skills

Joint attention and social orienting are the main precursors of SC development and are, therefore, the basis for developmental difficulties, which require further diagnostics and the development of interventions (Franchini et al., 2017). The response to joint attention and the development of social orienting has been significantly linked to language development and social interaction profiles of autistic children (Edward et al., 2015). Both social orienting and joint attention are critical early learning abilities that encourage further language, cognition, and social skills in autistic individuals (Mundy and Stella, 2000). Social cognitive learning theory explicates that the development of early joint attention skills in autistic children serves as a precursor to language development in the future (Geib, 2018). The social aloofness in autistic children can be seen as the representation of early joint attention impairment, and their NV behaviour prevents them from attending to the communicative needs of their social partners (Shire et al., 2015). Therefore, additional support and assistance are needed to process social information to enable engagement with their social surroundings. It is essential to investigate how contemporary

techniques and technology can be incorporated to develop joint attention and address the social engagement needs of these individuals.

2.4.1. Joint attention and social communication

Joint attention refers to the tendency of an individual to coordinate their attention with their social interactive partners regarding a certain object or event (Gillespie-Lynch et al., 2013). Montgomery (2015) posits that joint attention occurs in SC and entails the behaviour of gazing at a mutual object of interest. Pointing and gesturing are also involved, and it is a particular aspect of joint attention that it makes use of gazing and eye contact to coordinate attention with the other person (Ferraioli and Harris,2011). Chiang et al. (2008) found that joint attention is crucial for the development of SC in autistic students, reporting that initiation and responsiveness in joint attention can be exhibited in young autistic children and that joint attention skills are significantly related to language and, more particularly, with expressive language (Fletcher-Watson and Happé, 2019).

Adamson et al. (2019) identified the link between early language development and attaining the developmental milestone of joint attention in autistic individuals. Moreover, Arunachalam and Luyster (2016) argue that in the lexical acquisition mechanism of autistic individuals, some children acquire words and language just like typically developing children, but a disrupted developmental pattern is observed in them such as unusual and disrupted speech segmentation, non-spontaneous use of sentences, and atypical patterns in some situations. The authors further relate this discrepant pattern of language outcomes to the NV cognitive difficulties of these children.

Research to date on developing joint attention and social engagement, both verbal and NV (Hanley et al., 2014), has identified different parameters that determine the SC development in autistic individuals (Shumway and Wetherby, 2009). This includes an object of interest or play to engage the child (Hanley et al., 2014; Xin and Leonard, 2015), one that addresses all the components of joint attention (e.g., tendency to focus on the partner's face, responding to joint engagement episodes, and initiating the joint reciprocity). This is critical for overall SC learning (Vaiouli et al., 2015). Thus, object-directed joint attention has significant implications for SC, basic social exchanges, and continuing interactions for social purposes.

2.4.2. Social orientation and social communication

A significant body of research has identified social orientation as an important developmental antecedent of social and communication progression (Mundy and Stella, 2000; Shire et al., 2015), and others have indicated that by the time they reach adolescence, some autistic children develop these abilities (Cleary et al., 2014; Flanagan

et al., 2015). Researchers recognise the training social orientation imperative in order to improve the SC of autistic children (Zheng et al., 2016). The lack of spontaneous orientation to social stimuli in one's natural environment is further closely related to social communication skills such as joint attention (Zhang et al., 2016) Social orienting refers to the child's ability to "spontaneously orient to naturally occurring social stimuli in their environment" (Dawson et al., 2004, p.272). The social orienting hypothesis of autistic individuals further highlights the inability of these children to prioritise social information, and this is reflected in their signature characteristics – i.e., SC skills (Fischer et al., 2014).

The social orientation proposition of autistic centres on the concept that the social differences and discrepancies in autistic children are linked to their inherent inattention towards social information and context, which relates to their reduced salience i.e., regulating attention to internal and external stimuli (Volkmer, 2011). Jones et al. (2008) relate that this ineffective social orientation is reflected at an early age in an autistic child, who makes less eye contact but looks more at the face of the other person and also shows inattention towards other social cues of visual and auditory information. These difficulties in social orientation skills have a cascading impact on the development of future social skills so a promising intervention is mandatory at an early age (Dawson and Watling, 2000). However, predictive signs may not manifest until the age of two years, according to some researchers, in both the social and non-social contexts. When they do appear, this can prompt action to determine a diagnosis and correct intervention (Elsabbagh and Johnson, 2016). The discrepancy in the display of social orientation at an early age is controversial and refuted by some researchers, e.g., Johnson (2014), who considers social orienting as just a consequence of autistic traits rather than a causal mechanism. Linking to this contradiction of social orientation difference, Chevallier et al. (2012) explains it as autistic children's reduced disposition and interest in becoming involved in social interaction.

In the given context, the idea posited by social motivation theory is that autistic children demonstrate a lack of orientation towards developing social contact, due to the development of reduced reward processing from social interactions, relative to typically developing children. Unruh et al. (2016) explain the aspects of preferential and attentional bias that may be associated with this issue underlying social orientation. The idea of circumscribed interest (CI), i.e., restricted and repetitive interest in certain things such as electronics, games, vehicles, and other mechanical tools (Anthony et al., 2013), may contribute to an increased fixated interest that may enhance their experience of reward and pleasure towards that CI and further impede their attention span from growing towards other social sources. Therefore, this non-social bias may further limit their social

interests and, likewise, their social orientation and motivation to experience other situations. Another argument for divergent social orienting also relates to reduced salience and social information processing notions in autistic children, i.e., difficulties in adapting attention to salient cues in a given context (Patterson et al., 2021), which is further associated with their irregularity of attention towards social stimuli (Zivan et al., 2021).

These dimensions of determining social orientation in autistic children emphasise the need to establish and determine aspects that impact their visual choices and consequent social behaviour. This also necessitates the need to determine factors that shape and stimulate the preferences for social sources and improve the orientation and attention of autistic children. Hull et al. (2017) specify that social motivation in autistic children lacks persistence and consistency and they may mask this behaviour in a given situation to avoid supposed expectations. Further elaborating the argument linked to the social motivation hypothesis that autistic children possess inadequate social motivation, Clements et al (2018) raised the question of whether this lack of social motivation relates to the fact that they perceive social stimuli less rewarding than other children. The findings of the study indicated that their lower preference for social stimuli relates to their atypical processing and may be an indication of restricted interest in social and non-social rewards.

According to social interactionist theories for language acquisition, the development of joint attention skills in autistic toddlers develops their social engagement and orientation during interactions, according to the interests and communication level of the child (Edward et al., 2015). Knowing that the development of joint attention skills is crucial for early language development is important in order to adopt a socially interactionist approach that could help autistic children overcome these limitations and improve their language development.

Hanley et al. (2014) discuss the concept of social interactionist approaches that facilitate the social participation and interaction of the autistic child in the presence of a teacher or parents. This is significant for interpretation and for timely responsiveness to the child's communicative attempt (Geib, 2018). Thus, this also corresponds to eliciting desired learning and behaviour through the caregiver's responsive scaffolding (Haebig et al., 2013; Vygotsky, 1978). Fletcher-Watson et al. (2017) argue persuasively that effective collaboration between a caregiver, child, and interactive intervention can foster the development of core skills in autistic individuals, including joint attention and pragmatic communication skills. Thus, through child-oriented strategies and instructional scaffolding, coordinated joint attention and orientation are said to establish communicative and reciprocal interactions (Bottema-Beutel et al., 2014). Therefore, in the view of social interactionist theory, early language development and social interactions can be effectively

developed, and sustained episodes of coordinated attention and orientation can be accomplished, if supportive joint attention (using interactive intervention or technology) and instructional scaffolding are provided (Fletcher-Watson and Happé, 2019).

The following section will elaborate on how ToM difficulties have also been found to be consistent with current conceptualisations of the social orientation approach and joint attention in autistic children.

2.4.3. Theory of Mind (TOM) and social communication

ToM is found to have a strong correlation with social, affective, and communication relationships with others (Berenguer et al., 2018; Zhang et al., 2016). A plethora of prior studies have found ToM difficulties in the autistic population; the notion that ToM difficulties contribute entirely or partially to SC impairment – a hypothesis that has significant transparency in existing research – needs further exploration for the investigation of other related dimensions (Kalas, 2012). The inability to understand the cognitive state of other people's minds is further related to limited spontaneous reciprocal communication that leads to aversion and indifference towards others (Fletcher-Watson and Happé, 2019). Figure 2 illustrates how ToM influences various dimensions in autistic children:

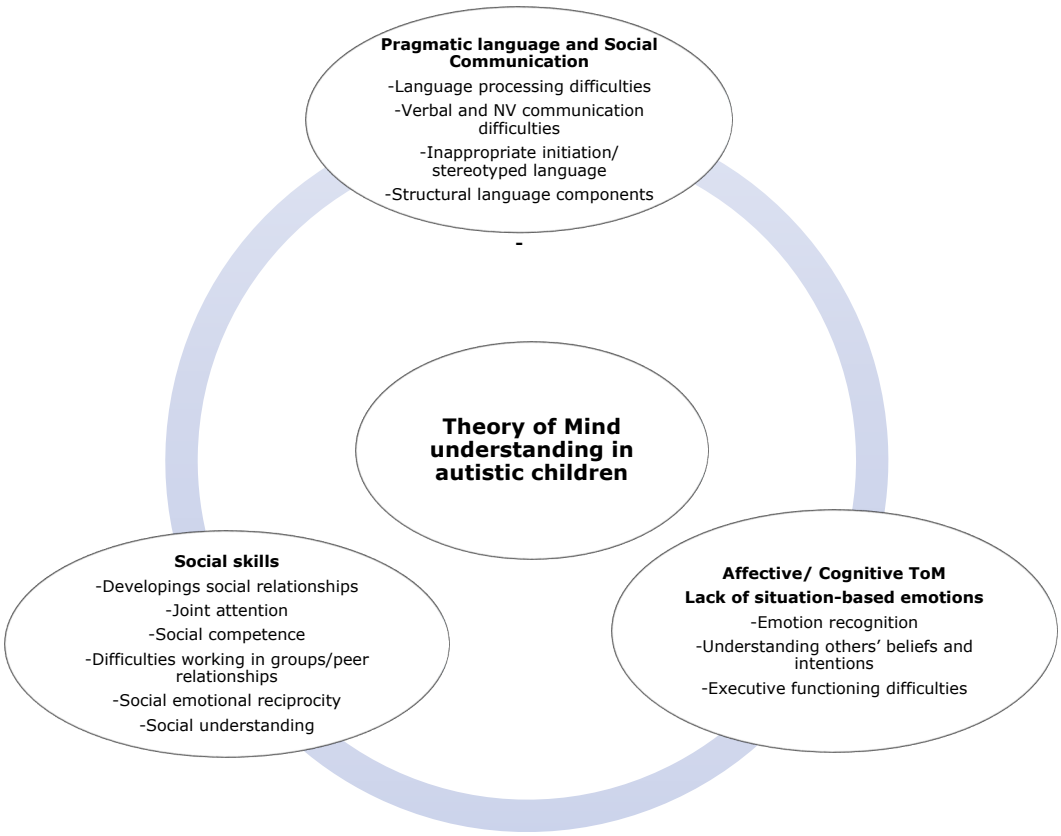


Figure 2 Impact of ToM on communication, social, and cognitive dimensions in autistic children

ToM challenges impact several dimensions of language and communication in autistic students, e.g., social, cognitive, linguistic, and emotional development, where the pragmatics of language (the ability to use language socially) is inadequate to the extent that they are unable to understand other people's state of mind. Understanding the impact of impaired ToM on the social interactions of autistic students is crucial (Siller et al., 2014). This is often due to challenges posed by a lack of adaptation of conversational maxim, poor speech maintenance, and inadequate eye gaze and meaning-making ability (Losh et al., 2012). These aspects are important for ascertaining the thinking and feeling of autistic individuals.

The essential concept of ToM is that the ability to infer another person's cognitive and affective predisposition is fundamental to the development of appropriate social behaviour (Mazza et al., 2017). Numerous researchers have indicated the multidimensional nature of ToM and considered it not a single process (Mazza et al., 2017; Mariano et al., 2017) but a product of cognitive and affective aspects where the former relates to the ability to

understand the mental state of others, and the latter refers to making inferences about others' emotions (Franco et al., 2014). Not all research considers ToM difficulties as a contributing factor to other SC impairments seen in autistic individuals, and thus there is a lack of universality of view of these difficulties (Van de Cruys et al., 2014). However, Brewer et al. (2016) argue that understanding the extent to which ToM difficulties contribute to other core difficulties is difficult due to the wide array of co-varying SC cues in different social exchange situations (Kuijper et al., 2017).

2.4.4. Receptive and expressive language in NV autistic students

In addition to various important aspects determining SC skills development in NV autistic children, it is illuminating to contemplate receptive language milestones and development in these children. Plesa Skwerer et al. (2016) found receptive language to be one of the crucial aspects of early social interaction and language acquisition in NV or MV autistic children (Plesa Skwerer et al., 2016). The difficulties with understanding and producing language, in the context of both receptive and expressive language function, greatly vary in autistic children (Boucher, 2012). Bottema-Beutel et al. (2014) explain how receptive and expressive language develop from early infancy onwards; the development of expressive and receptive language is initiated as an affective interaction that occurs face to face between infants and parents as early caregivers during the first month of their children's lives. Following these initial interactions, infants develop the ability to engage with things, objects, and others in a more progressively complex way. This is followed by the development of joint attention abilities and coordination of attention between the referent and others from the age of 6 months to 1 year, and by the age of 11 months, they can successfully sustain coordinated joint attention, manifested as gaze shifting between the objects and the person of interest.

Yoder et al. (2015) found that early communication skills in young autistic children can be used to predict how well they will learn language in the future. Nevill et al. (2017) state that among the early indicators of expressive and receptive language, deliberate communication attempts and parent linguistic responses were also found to be potential contributors. Considering the manifestation of these language elements at an early age, Hampton and Kiaser (2016) elucidate the findings from a meta-analysis of 26 studies that discovered the importance of executing early speech and language intervention for better receptive and expressive language results. Nevill et al. (2017) studied the predictors (nonverbal cognition, early communicative behaviours, and specific autistic characteristics) of receptive and expressive language in a community-based sample of 104 autistic children aged 1–3 years old. The findings of this study supported joint attention as a prime intervention target for improving receptive language skills but it did not predict

expressive language in young autistic children. However, the findings of the study identified the frequency of vocalisation as a contributor to expressive language. The study therefore emphasised how important it is to address joint attention through early intervention as an early step in helping young autistic children learn to understand language.

Several studies have reported a dissonance in the extent of receptive and expressive language in autistic individuals; i.e., some studies emphasise that receptive language impairment is common in autistic children (Norrelgen et al., 2015), while others report that expressive language is more impaired than receptive language and that this is a distinctive hallmark of autistic children (Weismer et al., 2010). The discrepancy between receptive and expressive language impairments is further explained in MV autistic children. For example, Rapin et al. (2009) mention that receptive language abilities in MV autistic children may entail better comprehension skills that may extend to more than one word, compared to those who only comprehend a limited number of words or phrases. However, the discrepancy in the level of impairment in both expressive and receptive language is linked to the validity of assessment tools and challenging standardised tests. For example, Tager-Flusberg (1999) mentions various challenges related to assessing and comparing the expressive and receptive language abilities of autistic children at varying levels of communication. These involve struggling to keep a child engaged during assessment; insufficient understanding of pragmatics in a given context while testing; distractions in the assessment surroundings; and anxiety and frustration while performing tests.

In the context of early intervention as an effective means of language development in autistic children, augmentative and alternative communication (AAC) systems are frequently incorporated as early intervention tools and complementary communication strategies for autistic children (Paynter et al., 2015; Romski et al., 2015). These help to bridge the symbolic communication gap, i.e., they enable links to be made between pictures and words, and between words and objects. Therefore, Romski et al. (2015) stress the need to incorporate AAC-based tools into an early intervention program that supports receptive language through an effective communication mode, leading to overall SC improvement in autistic children. Autistic children often rely on external stimuli to initiate, sustain, or terminate behaviours (Alzrayer et al., 2017), and Mirenda (2003) describes devices as stimuli that may compensate for receptive, expressive, and written communication difficulties. Researchers such as Alzrayer et al. (2014) and Alzrayer et al. (2017) have called for more empirical studies on speech-generating devices in order to determine how well these devices improve the communication challenges of autistic children

Given the aforementioned discrepancies in the extent of expressive and receptive language, there is a need to advance the research on the assessment of receptive and expressive language abilities, and to develop better assessment methods. This will broaden knowledge on these subdomains of language development in NV autistic children.

2.4.5. Motor skills and SC skills

The idea that motor differences may be contributing to the communication profiles of autistic children is not new (Mody et al., 2017). Motor skills difficulties are common among school-aged autistic children and may, in turn, limit their tendencies and opportunities for social communicative practices (MacDonald et al., 2013). This discovery, i.e., that movement difficulties are a fundamental aspect of autistic children, was first published in the 1970s (Bram et al., 1977; Damasio and Maurer, 1978). Since then, many research efforts and studies have identified and explored gross and fine motor delays associated with autistic characteristics (Jasmin et al., 2009). Bedford et al. (2016) stress the significance of motor milestones as crucial developmental markers specifically for social cognitive and communication development. Further emphasising the importance of these skills, the authors state that the development of gross motor skills in the early years of development, such as crawling, walking, and rolling over, is associated with the interaction and social skills of a child in later years.

Variations in fine and gross motor skills difficulties are exhibited differently at different developmental ages. For instance, Poser and Visconti (2022) reported that in the early years of autistic children's development, they usually exhibit delayed start of sitting without support; delayed independent walking and standing; and delayed acquisition of postural stability and coordinated head turning. Mody et al. (2017) and Ohara et al. (2020) further explain typical fine and gross motor skills difficulties as limited head turning, pointing and reaching out to things, and inappropriate hand gestures.

Other dimensions that were found to be related to these difficulties are motor coordination and planning issues (Rodriguez et al., 2019), perceptual–motor integration difficulties (Vanvuchelen et al., 2007), and difficulties linked to postural control (Minshew et al., 2004). Despite such evidence, the extent to which motor difficulties may be associated with communication and social development in NV autistic students has not been addressed adequately. However, prior research has determined that these delays in motor skills may negatively impact ongoing communication and social interactions in autistic students (Bhat et al., 2012).

As mentioned in previous sections, the SC difficulties of autistic children are quite obvious, and this has motivated the development of recommendations for best practices and

intervention programs to address these difficulties. Amid these recommendations, prior studies have indicated that practising developing skills is very important in order to apply the learned skill beyond the given setting (Rao et al., 2008), which will also promote the generalisation of skills in different contexts. For young autistic students, SC practice might include classroom activities and school-based play activities that require relatively proficient motor skills to participate with success (Ulrich, 2000). It has been suggested that the severity of motor skill difficulties is driven by intellectual ability; in other words, children with lower overall developmental levels have weaker motor skills (Green et al., 2009). Yet, research suggests that motor skill difficulties cannot entirely be attributed to intellectual ability (Lloyd et al., 2013). When a higher-functioning group of autistic children was compared with children with a motor-skill-specific disability, i.e., developmental coordination disorder, the autistic children had weaker motor skills (Green et al., 2002). This finding indicates the depth of motor skill difficulties in autistic children.

Mody et al. (2017) determined how motor skill difficulties relate to different dimensions of SC skills in autistic students. The motor difficulties exhibited by autistic children such as the ability to move hands, make gestures, and position the body, along with body posture and facial cues, further link to lower or poor NV communication. These difficulties may add to their inability to imitate NV cues. In addition to these difficulties, autistic children also exhibit uncoordinated and sluggish hand, head, and arm movements that further challenge their head turning, reaching for something, and showing and pointing towards something; this may impede their development of effective joint attention skills. The development of joint attention is a fundamental milestone for imitation and responsiveness in social participation, reciprocation, and interaction, specifically in physical actions. However, limited effective joint attention development also limits autistic children's ability to develop and practise required social skills in a given context (Ohara et al., 2019). The difficulties in motor skills relate to their overall social interaction efficacy, which is controlled by their ability to plan, perform, initiate and coordinate physical movements; an inability to do these will limit their social interactions with their classmates (Bhat et al., 2012). Therefore, this reflects how these intricate and connected motor skills are the foundation for SC skills development. In addition to this variety of motor skills in autistic children, gross motor skills, e.g., walking, is also imperative for social interaction and social skills as it enables autistic children to explore their surroundings, relationships, and objects (Hassani et al., 2022) and this is definitely also connected to the development of effective SC skills.

Another important dimension demonstrated in the motor difficulties of autistic students is their oral motor profiles. Some autistic children lack communicative speech, but their receptive language abilities are much higher than their expressive difficulties may indicate.

This discrepancy between expressive and receptive languages further relates to overall motor abilities, more explicitly limited oral motor skills. This is most obvious in NV and MV autistic children (Vidal et al., 2020). In the same context, the findings of a study by Page and Boucher (1998) clarifies this concept. The motor skills of 33 NV autistic students, aged 5–16 years, were examined and the analysis reported that 80% of the participants exhibited a peculiar motor difficulty, with oral motor challenges being more predominant that gross motor challenges. The intensity of the motor difficulty potentially influences their language impairment and therefore any delay in motor skill development associate with a delay in language development (Iuzzini-Seigel and Murray, 2017). Weisblatt et al. (2019) argued that there could be a discrepancy between the exhibition of receptive and expressive languages in the presence of motor skills delays. For example, some autistic children may show limited motor skills, but their receptive language can be exceptional relative to their expressive language, indicating their potential to understand rather than to express (Belmonte et al., 2013). Yet, the language development trajectory in autistic children may be discrepant and show varying patterns.

Users' interaction with icons is made easier by new technologies, which along with the understanding of how motor factors contribute to communicative challenges, might help users learn to interact with symbols. With the use of a tablets, this method aims to improve more fundamental abilities, such as vasomotor coordination and other motor skills, to refer to both iconic and more symbolic visual stimuli.

Weisblatt et al. (2019) highlighted in their study that, in contrast to a desktop computer user interface (UI), which tends to have a keyboard that requires precise motor control but lacks iconic, concrete references, technologies that are portable and keyboard-less hold potential for students with motor difficulties. The introduction of tablets is one such addition that is making it easier for teachers and practitioners to use them with autistic students. These interfaces are being used in multiple ways in teaching and learning, allowing autistic students to listen to instructions, access preferred stimuli, and even use these devices to communicate using different applications (Kagohara et al., 2013).

Fletcher-Watson et al. (2016) state that these devices possess the potential to be an engaging learning tool for autistic students. These learning tools can also improve their motor skills through various functions and features of tracing patterns that develop perceptual strength. In their study, Weisblatt et al. (2019) used a tablet-based application, Point OutWords, which builds on autistic perceptual and cognitive strengths, particularly of NV or MV individuals, to develop manual motor and oral motor skills, which are hypothesised to underlie communication difficulties and to be a prerequisite to communication by pointing or speaking.

McKinney et al. (2021) also utilised Point OutWords (directed for use by autistic children in collaboration with teachers and parents), with the aim of improving their communication development. The different interactive functions of the application enabled individuals to maintain attention and engagement, specifically through the customisation of exogenous cues, high-contract visuals and jigsaws that served as reinforcement prompts. Correspondingly, with specific vasomotor controls, the interface was adapted to redirect their frustration. Moreover, the features of the application also aim to enhance motor skills as a preceding requirement of communication development by keeping in view the cognitive strength levels of autistic children (e.g., through the representation and sequencing of patterns of puzzle pieces, symbols and their sounds). On the other hand, another dimension to this development is that the generalisation of these learned skills has not been assessed or recognised by prior studies. Weisblatt et al. (2019) remarked that some technology-based techniques that can be developed through game skills could be managed to generalise in real-life situations. Contrary to this, Fletcher-Watson et al. (2016) opined that there are no real context benefits of using application-based learning through social pictorial stimuli. The author further argues that SC difficulties are complex and that high-end SC skills cannot be developed through game-based learning and teaching tools, although a few natural behaviours have been reported and the execution of early interventions is important, as reported by existing studies. For example, Gulsurd et al. (2014) and Wass and Porayska-Pomsta (2014) state that early intervention aiming to improve joint attention and attentional gaze can produce more substantive results if it is executed at an early age, which will further have an effect on the development of expressive language.

In addition to the role of motor skills in developing SC skills, it is important to mention other predictors pertinent to the development of these skills. Chen et al. (2022) mentioned that ToM is a significant cognitive predictor of not only autistic students' social interaction in daily contexts, but also of their verbal comprehension and communication skills. The following section will reflect on this aspect.

In terms of empirical evidence, prior research has identified a close link between ToM and communicative abilities (Berenguer et al., 2018; Loukusa et al., 2014). In this context of ToM's significance for communication skills development, studies have widely acknowledged its relationship with all the basic components of SC skills, and a significant correlation has been found between ToM difficulties, social interaction, language processing, and pragmatics in autistic individuals (Vulchanova et al., 2015). Nevertheless, in the context of the present study, understanding and addressing the difficulties that

facilitate the ToM, i.e., joint attention and social orientation, can further support their SC skills.

2.5. Interventions and strategies for NV autistic students

As it is known that the primary predictors of SC skills i.e., initiation, requesting and joint attention, are quite influential in language development (Adamson et al., 2009), Gulsurd et al. (2014) posit that addressing these issues through early intervention will definitely improve requesting, commenting, initiating, and subsequent communication skills in autistic children. The interventions specifically designed to address joint attention and engagement are also found to be effective (Fuller and Kaiser, 2020) for spoken language in autistic children. Hampton and Kaiser (2016) explain how the shared experience that is motivated after engagement and joint attention in an activity will further direct autistic children to learn language through joint engagement and attention to words.

2.5.1. Evidence-based practice (EBP), interventions, and strategies for SC difficulties

The SC difficulties experienced by autistic children have been widely recognised by existing research (Lang et al., 2010; Fuller and Kaiser, 2020). There are calls for early interventions and appropriate strategies (Beukelman and Mirenda, 2013), as early regulation of these challenges can further improve autistic children's short- and long-term outcomes in life. Fortunately, promising research evidence exists on intervention approaches that address SC skills in autistic students and that are empirically supported in the domain of evidence-based practices (EBPs) along with various techniques and strategies accommodated by instructors and practitioners in a social setting (Watkins et al., 2017). However, the scarcity of literature on MV and NV autistic children has been identified by researchers, and the available research shows variations in terms of the procedures and data employed to characterise this group of autistic children (Koegel et al., 2020). Moreover, Chakrabarti et al. (2016) point out that in the past 60 years, very little research has focused on interventions for the group of autistic children who utter their first word after the age of two. This necessitates an expansion of the research base in this domain; these children have considerably limited verbal abilities and they are the most under-represented group of autistic children for interventions. It is imperative that specific guidelines and definitive strategies direct the selection of interventions; otherwise, those selected without any supporting objective data may lead to the ineffective or misguided execution of interventions. To have a clear view, it is known that almost all autistic children are NV or MV as toddlers, and some of these who are high functioning may exhibit verbal abilities

by the age of 3 years (Koegel et al., 2019). A credible evidence base is also crucial to enable the verbal abilities of autistic children, as training programmes, interventions, and classroom-based techniques alone cannot produce best practices, and may leave autistic children NV.

2.5.1.1. Popular interventions to address SC difficulties

Corresponding to this, Hampton et al. (2021) judged it important to have a blended approach of interventions to address the varying SC challenges in young autistic children, as this is a more effective way of improving targeted SC skills compared to the traditional methods of just relying on direct instructions. Studies have evaluated the efficacy of a multi-component SC intervention, reporting on the effectiveness and execution of different instructional strategies and interventions for different developmental groups (ages) of autistic students (Watkins et al., 2017). These pieces of evidence have shown that multiple and varied approaches are useful in a given context and situation for teaching specific SC skills. Also, the teachers and practitioners, being the primary facilitators involved in the execution of these interventions, ensure that a certain mix of approaches and interventions is potentially beneficial through the specific design of instructions, practice, and monitoring (Bishop et al., 2016; Rakap and Balikci, 2017).

Wong et al. (2015) presented an extensive review of evidence-based interventions and found 24 intervention strategies that lead to improvements in SC outcomes for autistic children. From this research, Watkins et al. (2015) explored EBPs that were specifically oriented to address SC difficulties and other impairments highlighted by DSM-V (i.e., the poor development of social skills, and inadequate social emotional reciprocity and overall social interactions), targeting different age groups of autistic children and other developmental difficulties. Watkins et al. (2015) further identified that different sets of interventions were suitable for particular age groups, ranging between 0–2 years of age (toddlers); 3–5 years of age (pre-schoolers); primary-school-age students of 6–11 years old; secondary school students aged 12–14, and students aged 15–18 years old. The prominent intervention sets highlighted were video modelling, prompting, reinforcement, the incorporation of visual support followed by naturalistic intervention, parent- mediated interventions, and pivotal response training; these were effective for all age groups. Watkins et al (2015) further mentioned that the obvious improvements in NV communication profiles for toddlers were significant, with major outcomes in joint attention skills, identified as attaining shared focus on an object and activity by two autistic children. Additionally, improvements in functional play skills were also reported.

Pecukonis et al. (2019) emphasised that the selection of any intervention is definitely shaped by multiple variables that are very important to consider prior to selection and execution. The selection of these interventions and pertinent variables further varies with age and other learning factors of NV autistic students, i.e., children and adults may vary in their suitability for a particular intervention. Chang et al. (2018) add to this view that interventions should ideally address multiple variables of a student, as one intervention cannot and should not focus merely on addressing language and communication development. Another dimension highlighted in the domain of effective SC interventions is their execution at an early age, as this brings collateral benefits in multiple aspects (Ledbetter-Cho et al., 2017). For instance, Pacia et al. (2021) quoted that administering interventions as early as the second year of a child's life is expected to decrease associated behaviour-related challenges and lead to greater developmental gains in the language and social profile of these students. However, Green and Garg (2018) state that "The overall quality of trials evidence in autism intervention remains relatively low, despite some recent progress; many interventions in common use have little or no evidence base" (p.1).

Prior studies have proposed another perspective, which is the use of a customised approach and a blended way of using different interventions and strategies. This is to ensure that an individualised and customised approach could work for individual autistic students or for a group of autistic students sharing similar complexities and challenges. Kryzak and Jones (2015) point toward this view when they say that teachers, when administering an intervention, sometimes change other measures, e.g., changing the intensity of prompting procedures to develop requesting skills in autistic students. For example, Waddington et al. (2014) examined how teaching multi-step requests with an SGD involved the modification of different procedures in the intervention, such as administering the planned procedures of the intervention in two ways for each participating autistic student. Another aspect to this view is the modification of individualised interventions, such as in the format of the display icons on the communication device for one of three participants. In the same study, another participant did not welcome physical prompts, so these were then changed from physical to verbal and gestural prompts, and after each trial, the participant was given access to an edible item.

2.5.1.2. Popular strategies and techniques for SC challenges

Modern research shows robust support for a diverse range of effective strategies and techniques to address SC difficulties in autistic children, i.e., employing multiple intervention components to address a comprehensive set of behaviours and skills (Lang et al., 2016; DeBar et al., 2022). For example, one of the most cited interventions and approaches is peer modelling or coaching, which has been found to have positive impacts

on SC skills, specifically initiations and responses to questions from peers (Watkins et al., 2015), and social interactions, specifically during play (Kamps et al., 2015). These interventions further include video modelling interventions as well-designed instructional strategies to address various SC responses (Qi et al., 2018).

Prompting as an instructional technique is quite common in different interventions for autistic students, sometimes in addition to reinforcement behavioural strategies. Landa et al. (2018) identified that prompting is effective, and when teachers incorporate it as material placement, or certain arrangements in a given learning context or expectant waiting, it helps to improve social interaction. Furthermore, when the student is allowed to access their desired object in that given setting through reinforcement, it yields social reaction too. The most positive results are observed when reinforcement is given right after social interaction behaviour, i.e., more frequent interaction and reaction.

Another widely mentioned strategy, the video modelling technique, is also significant and effective for autistic children and adults. This technique makes use of short video clips that show the target behaviour, to provide learners with a learning opportunity through the demonstration of positive exemplars. The effectiveness of video modelling has been mentioned in prior studies, and when it is used in combination with other strategies it is said to produce more effective gains. Marzullo-Kerth et al. (2011) identified prompting and reinforcement strategies as effective in a video modelling intervention administered for three autistic students in a school context. It increased the helping behaviours of those students (e.g., sharing toys, snacks, and other materials). The follow-up of the intervention demonstrated increases in sharing behaviours not only during training, but also during the maintenance phases.

Other notable strategies to develop the SC profiles of autistic students include training peers to initiate play with autistic children and the use of scripts and visual cues. Owen-DeSchryver et al. (2008) state that peer-mediated training improves initiation skills in autistic students. Similarly, Flores and Ganz (2008) report the role of visual strategies and script training procedures in addressing expressive communication and diminishing preservative speech. These strategies are convenient to execute as they require the minimum use of resources by the teachers. Moreover, visuals are said to be more effective than verbal prompts and reminders as they are less interfering and have a less stigmatising effect. In a classroom setting with students with varying learning difficulties, the use of visuals is less distracting and interfering, particularly if the students are also using prompts and cues (Ganz et al., 2008).

Manualised naturalistic teaching strategies have also been identified as effective natural strategies to help improve SC skills in autistic students. Charlop et al. (2018) describe these as flexible teaching strategies executed in a loosely structured natural context that usually motivate the students to interact and develop functional relationships. Moreover, it is an amenable strategy for developing social interaction skills, which have potential maintenance and generalisation across contexts. Nunes (2005) mentions that the underlying developmental procedure to this technique allows teachers and instructors to consider a student's preferences, i.e., their attention span, and their activities of interest that will facilitate interaction. In addition to the natural structure of the setting, this strategy also ensures that interactions are flexible rather than following any scheduled protocol and design; this whole process also requires significant attention and responsiveness from teachers during each attempt at communication and social interaction that the student makes (Prizant et al., 2000). The widely practiced naturalistic procedures include Enhanced Milieu Teaching (EMT) and Pivotal Response Training (PRT) (Kasari et al., 2014). In the context of effective interventions for autistic children and other neurodevelopmental disorders, EMT has been reported to be effective (Hampton et al., 2017; Kaiser et al., 2017). A naturalistic approach is accommodated in this strategy where natural environmental arrangements, interactions that lead to responses, and prompting techniques are organised in a way that facilitates the development of SC skills (Kaiser and Hampton, 2017). There is research evidence that supports the effectiveness of EMT with other strategies such as Joint Attention, Structured Play, and Emotion Regulation (JASPER). Hampton et al. (2021) postulated that this combination motivates joint attention and engagement in autistic students and also leads to the maintenance of the learnt skill in different settings for NV autistic students. The results of this research by Hampton et al. (2021) identified that although all the autistic students exhibited improvements in their spoken language skills, those who were exposed to the blended approach and intervention, i.e., with the addition of a speech-generating device, performed better than the students who were trained using only JASPER+EMT.

Koegel et al. (2019) conducted a systematic review that encompassed a mix of strategies and interventions that can produce improvements in the SC skills of NV autistic students in a given context, such as naturalistic teaching strategies, peer-mediated communication, and blended behavioural approaches. The study further mentions that there was a lack of consistency regarding which interventions were employed. For example, some studies recommended the use of augmentative programs (signs/pictures/computer programs) along with or before targeting verbal communication, while others did not recommend their frequent use.

Irrespective of the actual program utilised, there is support for the use of naturalistic interventions owing to the complexities of NV autistic children. Koegel et al (2019) explicate that effective and efficient intervention execution may initiate the SC providing considerable opportunities in given social settings. The following table illustrates interventions and strategies for managing SC in NV autistic students, as identified by Koegel et al. (2019).

Table 1 Effective interventions and strategies used to manage SC in NV autistic students

Author and Year	**No. of Participants (M, F); Age**	**Measures**	**Intervention/strategy**	**Outcomes**
Franco et al. (2013)	6 (5M, 1F); 5–8 years old	Frequency of acts and responses produced during each routine to maintain social interaction. Total responses produced as child-initiated communication responses (rate/minute of each response).	Pre-linguistic milieu intervention: supplemented with instructional techniques i.e., external prompts, modelling behaviours, and natural consequences in a naturalistic play setting.	No display of communication responses during baseline. Improvement in rate of initiation and intentional communication during intervention of all six participants.
Gordon et al. (2011)	84 (73M, 11F); 4–10 years old	Number of initiations (both verbal and NV) and requests. Vocalisation, a separate measure. PECS.	PECS and verbal modelling.	Positive yet moderate training effects. Requesting (object). No improvement in SC in significantly NV autistic students.
Koegel et al. (2020)	3 (3M); 3–5 years old	Intensity of reinforcer. No. of engagements that were self-initiated during interaction and communication.	Child preferred reinforcer to motivate social interaction. Naturalistic language intervention	Gains in self-initiation. Gains in social engagement in all three participants.
Strasberger and Ferrari (2014)	4 (4M); varying ages: 5, 8–12,		iPod as SGD device.	Gain in communication through use of

	and 11 years old		Peer-assisted communication application (PACA).	iPod SGD application in all four participants. Generalisation and maintenance of new communication skills in two participants.
Shire et al. (2015)	22 (all M); 5–8 years old	Various spontaneous commands such as requesting, commenting, and other non-social cues.	JASPER-EMT individually or JASPER-EMT + SGD (blended)	Gains in spontaneous requests and comments. Comments from teachers were "moderately significant".

The effectiveness of interventions, strategies, and other approaches are significantly shaped by various other factors. It is important to mention the role of reinforcers and motivators in the context of this study. The following section highlights the importance of using reinforcers and motivators to direct NV autistic students.

2.5.1.3. Significance of reinforcers for NV autistic students

According to Koegel et al. (1988), developing SC skills is challenging in NV autistic students. However, previous research has shown that the use of motivators is a key factor in fostering the desired behaviour, in this case, training autistic individuals to communicate and interact (Schuetze et al., 2017). In their study, Koegel et al. (1988) aimed to develop motor speech approximations through the use of reinforcers and motivators where one student's speech attempt was reinforced and were found to be clear relative to their speech sound. The reinforcers were shaped by keeping in mind the learner's interests, enthusiasm, and overall behaviour during the intervention phase.

When determining the role of a reinforcer in developing SC skills for autistic students, Schuetze et al. (2017) recommend conducting a reinforcer preference assessment. This increases the chances of a successful deployment of a reinforcer in interventions. Kang et al. (2013) add to this view that a learner-oriented reinforcer would be a potential trigger and stimulant with the required effects to direct learning in systematic learning procedures (Trosclair-Lasserre et al., 2008).

Penrod et al. (2008) identified in their study that typically developing students exhibited the desired behaviour more effectively through the use of their preferred stimuli when

their learning and teaching were quite challenging in the absence of that reinforcer. This demonstrates the need to conduct an accurate preference assessment of the reinforcer that may direct and shape the learning of NV autistic students. In the same context, Klintwall and Eikeseth (2012) mentioned the use of socially mediated reinforcers for autistic students. Teachers can employ these reinforcers, such as toys and food, with students.

Klintwall and Eikeseth (2012) further mention that the use of socially mediated reinforcers is more effective in producing the desired communication outcomes than automatic reinforcers, which could not produce the desired results. This presents an interesting perspective that the type of reinforcer matters a lot in directing the learning of autistic students, and teachers need to choose these reinforcers carefully in order to yield better student learning and eventual outcomes. Reinforcers to be used with autistic students should be chosen while considering their challenges and the given context.

The following section entails a comprehensive review of technologically mediated interventions for SC skills in autistic students.

2.6. Digital technology for SC skills

Technologically mediated interventions have been highlighted in prior studies to help to address various challenges related to autistic children. Boucenna et al. (2014) established that the development of successful and effective technological tools has taken place over the last decade. The rapid adoption of digital technology has been found to be beneficial for facilitating SC in autistic individuals (Clarke et al., 2015; Kagohara et al., 2013). The contribution of digital devices is considered innovative in helping students with learning disabilities (da Silva et al., 2011), specifically those struggling with communication difficulties, and in maintaining social interactions (Boucenna et al., 2014; Konstantinidis et al., 2009). Stančić et al. (2011) state that digital devices are inclusive of wider categories of technological solutions, such as the different products, services, systems, networks, methods, and techniques that contain, manage, restore, and display information electronically. The European Commission emphasised the integration and adoption of digital technologies and devices and pointed towards their significance in supporting students with learning disabilities (Stančić et al., 2011). The integration of technology into education creates a learning setting that is more student centred. Digital devices and applications have the ability to accelerate, innovate, deepen, and enrich skills (Eonta et al., 2011).

The use of technology-based interventions has been recognised as a provisional instructional aid by previous studies (Goldsmith and Leblanc, 2004). The effectiveness of these handheld tools and devices has been further advocated by their convenience of use and presentation of content. For example, Knight et al. (2013, p.646) state that handheld devices are a "convenient interface for autistic students to present visual information in a sequential and designed way". There is a need for empirical studies that clearly determine the effectiveness of tablets in the teaching-learning context of autistic students and in addressing their SC difficulties (Alzrayer et al., 2014). Goldsmith and LeBlance (2014) state that these devices are suitable for prolonged use as an assistive tool if they retain the accomplishments in the behavioural modifications of autistic children. Provided that these devices maintain their effects, such as interest and focus of individuals to practice and repeat the activity, they can be used as an instructional tool and as a constant EBP (Alzrayer et al., 2014).

Since the inception of technological tools to address autistic students' difficulties, a constant effort has been executed by researchers and practitioners to determine the validity, practicality, and generalisability of these interventions. These efforts further determine any substantial differences and contributions made to improving autistic students' core difficulties (Bond et al., 2016). Vivanti et al. (2014) signified that the different interventions utilised in prior studies to address SC skills in autistic students could not be generalised in a different context. In order to determine the effectiveness of any intervention, whether technologically mediated or not, the generalisation of the improvements in SC should be determined in a way that illustrates the actual effectiveness of the intervention in helping the learner exhibit the skills in different contexts, not only in the original learning environment. Relevant to this, Cruthers et al. (2020) found that prior studies have mentioned the difficulty autistic students face when they have to utilise the learned skill in a different context. Hence, generalisation has not been successful across different contexts.

The efficacy of technological interventions used with autistic children has been cited by prior studies. For example, Goldstein et al. (2014) explained that if the right assistive technology is chosen, which is compatible with the learning style and challenges faced by autistic children, it can help address their SC skills. Moreover, the study reported the improvement in motivation, attention, and drive of autistic students with the use of technology that was not accomplished through traditional means of teaching and learning. In addition, Goldstein and Naglieri (2014) mentioned the findings of Ennis-Cole and Smith (2011) and Goldsmith and LeBlanc (2004), suggesting that technologies facilitate development in social, communication, and other skills for autistic children. However,

several factors are associated with success in using technology-based interventions with autistic students. Wendt et al. (2019) noted that there is neither a single protocol for digital devices nor traditional intervention like PECS. The authors mentioned that both approaches in a given context have their own advantages and disadvantages, but of course, one precedes the other in terms of benefits. Aspiranti et al. (2019) presented conflicting views concerning the use of digital devices for addressing the challenges faced by autistic students. The authors argued that varying evidence and conclusions had been presented in prior studies despite the promising benefits of device-based learning in autistic students. For example, Grynszpan et al. (2014) carried out a meta-analysis and found that with a low sample size, moderate effectiveness of the digital application is accomplished. This argument relates to the findings presented by Thiemann-Bourque et al. (2018), where 45 NV and MV autistic students were trained using a speech-generating application on a tablet using a peer-mediated approach. Significant improvements in communication responses and initiation rate (reciprocity) were reported, followed by the generalisation of the learnt skill.

Findings from previous interventions for improving SC difficulties have therefore elucidated the mixed views on their applicability and effectiveness, as the gains made post-intervention were seen to diminish after a certain period of time. Bond et al. (2016), Grynszpan et al. (2014), Kaur and Pany (2016), and many others face criticism for their methodological controversy (Carter et al., 2017). The results reveal no immediate impact on targeted core skills in autistic individuals, nor were there any obvious gains or improvements in the social repertoire of the targeted autistic students (Kim et al., 2018).

However, there are many preparations that need to be considered when executing technology-mediated interventions for autistic students. For example, in order to sustain the effectiveness of these interventions, facilitators have always stressed the importance of implementing them in the early years of life so that the gap between identification and therapy/training is shortened (Camarata, 2014). It is also important to consider the role of teachers, practitioners, and parents, keeping records of regular developmental evaluations, promoting the targeted skill through interactive approaches, helping children to develop the skill in more naturalistic settings, and supporting the intervention through positive behaviours (Nunes et al., 2016). The findings presented by Knight et al. (2013) suggested that the execution of technology-based interventions should be administered by teachers with caution. This is because it is imperative to conduct extensive monitoring of the progress made by the autistic students so that the success can be attributed to the role of the use of technology relative to other interventions, i.e., general instructions and strategies. Ploog et al. (2013) mentioned the efficacy of technology-mediated

interventions for autistic students, but indicated the need to make the unique design of each intervention compatible with the level of difficulty faced by the autistic students.

2.6.1. Role of AAC in enabling SC

In the domain of using technology for SC skills in autistic students, the use of AAC has gained increasing attention, and the vast majority of the AAC research focuses on NV autistic children (Zisk and Dalton, 2019). Referring to the effectiveness of these AACs, Shane et al. (2012) indicate advances in devices like tablets as AACs because they are greatly accessible, affordable, and socially accepted, meaning that users do not feel stigmatised when using them (Kagohara et al., 2013). Moreover, their easy-to-use interface and customisable applications enhance acceptance by parents and teachers (Boyd et al., 2015). These devices range from low-tech (communication books and speech devices) to high-end technology devices (e.g., computers, tablets, laptops). The most effective, as mentioned by prior studies in the list of AACs used for these students, include manual signs, graphic symbols, and speech-generating devices (SGDs) (Logan et al., 2017). SGDs, considered as high-tech AAC, is said to have the greatest potential for addressing the communication challenges of not only autistic children but also autistic adults. Recently, a more advanced version of these tools, i.e., handheld multipurpose digital devices (e.g., Apple iPad, iPod Touch, Android tablets), are being incorporated into teaching for autistic learners. This frequent use and adoption relate to the efficient performance, ease of accessibility, and cost-effectiveness of these devices. From this perspective, these AAC devices are also said to have more potential than other traditional tools, due to their feasibility in training and use.

The goal of AAC interventions and strategies is to assist individuals with communication difficulties in order to overcome their inability to communicate and understand, and to meet their need to express themselves (Mirenda, 2001; Light and McNaughton., 2014). Moreover, the choice of AAC is significantly determined by the ability and difficulty level of autistic children (e.g., imitation skills), their preferred learning mode, and the durability of the specific tool (Lorah et al.,2018). AAC devices can be divided into two broad areas: aided devices and unaided devices. The unaided AAC strategies included manual signs and gestures. The most common aided, low-tech augmented tools used are pictorial or written schedules to help children follow through with a particular activity (Quill, 1997; Wood et al., 1998). The other AAC tool that is widely used is the Picture Exchange Communication System (PECS), this is a structured behavioural intervention programme that uses visual/graphic symbols for communication (Frost and Bondy, 1994).

The use of evidence-based AAC in teaching and instructional procedures is said to address the complex communication needs of autistic students. For example, the National Autistic

Centre (2009) elucidates that the efficacy of AAC methods is enhanced if they are blended with operant instructional procedures. Many prior studies have acknowledged this view, i.e., the efficacy of AAC is enhanced when systematic instructions are coupled with the use of these tools. To add to this view, the systematic review presented by Kagohara et al. (2013) demonstrated that systematic instruction is one of the main components in the effective execution of SGD as a communication improvement tool. Additionally, researchers in several studies have reported the use of other strategies as being effective in improving SC skills using devices (Van der Meer and Rispoli, 2010; Alzrayer et al., 2017). For example, the use of differential reinforcement of alternative (DRA) behaviour along with AAC devices is a potential mix in the teaching–learning process for autistic students. DRA is a commonly used function-based intervention that is effective in lessening challenging behaviour. A functionally equivalent targeted behaviour is reinforced by withholding or minimising the reinforcing of the undesired behaviour at different intervals (MacNaul and Neely, 2018)**.** In other words, differential reinforcement is an effective strategy that may direct autistic students to utilise these devices and applications effectively in order to develop and exhibit SC skills.

The effectiveness of using a particular technology is also dependent on the foundations of EBPs in place when used in combination. For example, McNaughton and Light (2013) describe different dimensions to be considered to determine the efficacy of this approach. First, a careful assessment is required to determine the efficacy of an AAC intervention; this can be undertaken by proficient practitioners who take into consideration all the related factors (learner's learning needs, skills, challenges, support opportunities, and limitations). Second, for any intervention, including AAC, the student's needs and skills need to be assessed in order to further accommodate the required modifications to match their learning style and needs. Third, simply having access to devices will not lead to an improvement in SC skills; rather, a combined intervention is required to develop functional and demonstrative communicative competence. Lastly, in order for an intervention to be potentially effective, the incorporation of communication partners is also important, and their knowledge and skills should be adequate to effectively support autistic students (McNaughton and Light, 2013).

It is also important to address and consider the success factors important for the implementation of AAC to improve communication and enhance participation for autistic students with significant SC challenges (e.g., Beukelman et al., 2007; Fried-Oken et al., 2012). These factors also serve as potential principles when an AAC-based intervention accommodates the use of a tablet with relevant applications. In this context, McNaughton and Light (2013) also established that in order to realise the benefits of technological tools,

it is critical that their application is guided by the use of AAC (Bryen and Ervin, 2012). There is a need for further evidence to determine the efficacy of assistive devices, as Alzrayer et al. (2019), elucidate the progress in communication skills of autistic students aged 7–10 with the use of a tablet and call for further evidence to determine the efficacy of assistive devices. The research identified improvements in the overall teaching–learning process, specifically addressing communication skills and social orientation by supplementing the use of a tablet with strategies like least-to-most prompting, constant-time delay, error correction, and reinforcing students to request preferred items, respond with "thank you", and answer personal questions. On the whole, the study showed the positive contribution of tablets in improving foundation skills i.e., engagement and communication (Alzrayer et al., 2019).

Other significant evidence was presented by the study of Van Der Meer (2016), who illustrated that different AAC devices and tools (manual signs, picture exchange (PE), and SGDs) motivate and direct autistic students towards engagement and producing multiple SC responses. The findings demonstrated the acquisition of multi-step requesting and SC skills in two autistic children who were NV and MV and who had been previously taught to request their preferred objects. The post-intervention results showed improvement in their targeted responses, i.e., multistep requesting, greeting, answering questions and social etiquette responses (thank you), whereas at baseline there were significantly fewer correct communicative responses. The study also identified the preferences of the participant students, as one of them was more oriented to learn through an SGD and the other through PE. However, the mutual finding was that both of the participants were motivated to learn and engage in activities with each AAC option.

2.6.2. Affordances of digital technologies in managing SC

Researchers suggest that motivating objects such as various interactive games applications can help to facilitate improvements, and increase the performance, attitudes, and skills of students, which is especially important for special education students (Kern et al., 2007). These applications also encourage attention through social orientation, for example by pointing, gesturing, or gazing at the object (Kalas, 2012). Maintaining the interest of individuals against competing stimuli (LaGasse, 2014) is expensive using common interventions (Kalas, 2012), yet costs are reduced with the use of technology-based support (Fletcher-Watson et al., 2014; Fletcher-Watson and Happé, 2019). O'Brien et al. (2011) affirm that the role of the teacher is crucial in offering creativity and engagement when they use technology in their classrooms, allowing autistic students to feel included.

The use of ICT-based devices such as tablets has significantly increased in mainstream schools globally (Fletcher-Watson et al., 2017; Grossard et al., 2018). Tablets have successfully been used with autistic students to request preferred items, label objects, share information, and engage in social interactions. With reference to the developmental precursors relevant to the development of SC skills, i.e., joint attention, social orienting, and ToM, technology-based devices are found to contribute to engaging autistic students and even other subgroups, including NV autistic students (Grossard et al., 2018; Mangafa et al., 2015). Positive outcomes have been reported in terms of the efficacy of technological devices in enhancing SC skills in autistic students, and positive dimensions have been reported in the use of technology in cultivating the interactive settings important for establishing joint engagement, social orienting, and social understanding in autistic students (Grossard et al., 2018; Hourcade et al., 2012). However, there remains a gap in the research in terms of addressing the sustained success of interventions and their generalisability in other settings.

Another way to examine the effective role and contribution of digital devices is through scaffolding. Wood et al. (1976, p.90) elaborate on the concept of scaffolding as the assistance provided to learners on an "as needed basis", to enable them to acquire the required skills and accomplish tasks that they could not accomplish independently. Scaffolding entails the simplification of a task into steps by a knowledgeable instructor who uses verbal and visual prompts, and also modelling the desired behaviour to facilitate successful learning. In situations where a new skill is to be learned, additional support and guidance are needed. However, the support and guidance fade with time gradually when the learner starts exhibiting the desired behaviour and learning goal, until competence develops. Scaffolding is found to be an effective strategy that enhances learning across a wide range of content, domains, ages and abilities (Wood and Wood, 1996). Effective scaffolding might further benefit learning because it is a positive way of reducing the errors made on a task, resulting in faster and more robust learning (Waddington et al., 2014).

Xin and Leonard (2015) explored the development of communication skills in three 10-year-old autistic students, with little to no functional speech. Through multiple baseline designs, students were given access to a tablet-based speech-generating application Sonoflex across academic and social settings. It was recorded that during the baseline phase, there was no apparent improvement in communicative attempts when the students were given access to tablets. However, during the 6-week intervention phase, the students learned to communicate with teachers and peers with least-to-most prompting. The communicative response was observed to increase in terms of the students' receptiveness to instructions and questions, followed by increased initiating requests (expressive

communication) and making social comments within both academic (classroom) and social (recess) settings.

Critics of the traditional style of techniques mention that the opaque way and mode of learning presented by traditional picture and card systems using more drawn objects and icons may be discrepant to the real-life objects that may make it difficult for autistic learners to generalise when they see the object in reality. The affordance and efficiency of digital technologies enable the representation of referent objects in multiple ways and even allow the representation of real objects through videos and in-built cameras.

Kucirkova (2014a) found that the ease of adding personalised content, i.e., adding photographs, audio, and text comments to create a narrative and story for an autistic student, is an ultimate benefit that enables teachers to enhance student engagement with the task. Similar motivational and reinforcing contributions have been reported by Kucirkova et al. (2014b) and Critten and Kucirkova (2015), that made use of a story creation application (app) to address the language and communication difficulties in autistic students that allowed the use of multiple variants in creating personalised narrative for each student digitally. Thus, personalisation could be potentially used to facilitate engagement and improve communication and social skill difficulties.

Contrary to this, there are views that go with the notion that technology is not the solution to every problem associated with autistic students. Yu et al. (2008) mention that technology cannot be the sole replacement for all learning experiences that can be accomplished through other means. However, the facilitative role of digital technology is distinctive in that it uses audio-visual and sensorimotor experiences and attention in developing communication skills in autistic children. Furthermore, relying only on the screen cannot replace teacher mediation and guidance; the two-dimensional (2-D) representations on a digital interface do not afford manipulation and monitoring of a real-life guide nor provide cues from the teacher's direction of gaze (Flewitt et al., 2014). Having mentioned these criticisms, the advocates would still acknowledge the role these digital technology play in enabling learning through easier access, availability, and extra processing time (Southall, 2013) and also overcoming the learning anxiety associated with face-to-face interactions autistic students face in the classroom.

Having an increased preference for the integration of tablets in special education, especially the preference of autistic students to use it, it is important to discuss the affordances it offers relative to other interventions and tools. The following section elaborates on this dimension.

2.6.3. Efficacy of tablets for facilitating SC

It is pertinent to discuss the factor of preference and interest in using tablet-based interventions that are said to produce more important advantages relative to other AAC devices in autistic students (Lorah et al., 2013, 2015). The preference for using the tablet is said to improve learning tendencies, and the likelihood of using different applications elicits greater communication gains, therefore generating greater learning improvements. In addition to the tablet preference in learning relative to traditional methods, the tablet has the potential for engaging students more and retaining them for longer on tasks that could not be accomplished through conventional means of learning and teaching. Research to date supports this notion that interventions delivered with a tablet result in greater engagement and reduced challenging behaviour during the intervention period compared with interventions delivered by teachers (Fletcher-Watson et al., 2015; Lee et al., 2015; El Zein et al., 2016). However, these studies focused more on how students were motivated toward learning sessions when they were engaged using a tablet rather than on demonstrating the learning improvements. But, this criticism is restrained by Dweck's (1986) view that motivation is the essential and driving force towards the acquisition and transfer of knowledge. Therefore, the potential of these technologies to motivate can be exploited for better learning with the passage of time, and research needs to identify how it can be accomplished.

Relative to this, some studies have also reported that tablet-based interventions are not, or are less, effective in yielding improvements in any aspects relative to other interventions that aim to address specific SC skills. For example, Agius and Vance (2016) found that improvement in communication function, i.e., requesting skills, was obtained through training on both PECS and tablet-based applications with no difference in the timeframe. Moreover, the study also reported that the participating autistic students developed requesting skills to a similar extent, but less prompting was required with the use of PECS than with tablet-based learning. In addition, the follow-up data revealed that tablet-supported requesting faded with time, thus there was a low maintenance of the learned skill over time. Having assessed both technology-mediated interventions and other approaches, it is relevant to mention the view of Weisberg and Jones (2019), who state that the holistic efficacy of any single intervention cannot be determined, or a particular intervention cannot be singled out, as a fully-fledged solution to SC challenges.

Wendt et al. (2019) established the advantage of using tablets over other traditional learning tools for autistic students, such as PECS. The study elaborated that the speech-generating feature on tablets provides additional verbal modelling and the repetitive production of sound will help direct the autistic student to try and improve their speech

too. The auditory tools also have reinforcing power that may motivate autistic students to use them for communication. Interchangeably, the power of the tablet and its features may work as a conditioned reinforcer to yield expressive responses in autistic students as well. In addition to this, other studies further corroborate these potential uses of technology-based tools to help improve communication skills in autistic students. McLay et al. (2017) found the preference of autistic students more towards PECS and SGD than manual signs. During the probe session of this study, the participant autistic students selected SGD exhibiting their preference. The author inferred that the reinforcing impact of these digital speech-generating tools is a critical function that shapes students' preference for this choice. Also, the study indicated that PECS-based communication and interaction might limit the exchange of communication with only those who are familiar with this modality. Another indication for using picture cards identified by Boesch et al. (2013) is that they need to be recreated in case of loss and damage; however, various applications of digital devices are advanced that allows a variety of options for graphic symbols and stored pictures through camera options -reducing the burden of creating conventional tools again.

Other studies mentioned that it is not pertinent what medium is used for visual learning for autistic students, but the nature of visuals (pictures) being presented shapes the learning more effectively. For example, Allen et al. (2016), in their small-scale study, didn't find any substantial changes in the communication skills of autistic students through the use of tablets relative to traditional PEC systems. Their study consisted of 16 minimally verbal autistic learners who had been learning through PECS more often with recurrent exposure to tablets in the classroom setting. The study focused more on the influence of presentation through different media, i.e., assessing the learning tendencies of students presented through four different interfaces and teaching them the names of different objects. For example, an interchangeable sequence of presenting different objects through tablet and picture cards and books was incorporated. The participants were shown a single representation of the targeted object repeatedly using a tablet, then using picture books; a similar pattern was repeated and then using multiple representations on a tablet, followed by showing similar representations on a picture book to see their learning patterns and differences in presenting through a different medium. The findings deduced that the choice of medium did not influence students' tendency to remember the names of pictures and real objects. But what was found important was the nature of the picture being presented that could later be generalised to real objects by autistic students, whether presented on a tablet, picture books, or cards.

In comparison to this, Lorah et al. (2015) mentioned improvement in communication profile is definite as they cited the findings of one study where 93% of the participants exhibited communication responsiveness using a tablet as a multifunctional device for speech generation. Achmadi et al. (2014) and Couper et al. (2014) related similar views that the tablet is a preferred tool relative to other AAC devices (manual signs, language, and picture exchange protocols) in learning communication for autistic students, followed by improvement in maintenance of learned skills, less time in learning relative to traditional techniques.

Pertinent to the context of the current study, the relevance of understanding the importance of digital technologies is crucial, and how teachers' efficacy relates to the use of digital technologies to support SC skills in NV autistic students. According to earlier studies, using a tablet has been helpful in enhancing autistic students' learning tendencies. Alotaibi and Almaliki (2016) explained how teachers found the tablet a beneficial interface for autistic students to be incorporated as an instructional tool along with other materials they use in classrooms. Prior studies have mentioned multiple reasons for the popularity and increasing acceptance of tablet use. Perry and Steck (2015) explained that the reason for this positive attitude and realising the positive role of the tablet is the increasing incorporation and acceptance of these digital devices in educational activities. Another reason for the popularity, as reflected by Schlosser et al. (2017), is that tablets are facilitating devices that can be easily connected to the internet at any time due to their ease of portability, which allows students to access the content of their choice independently and even under the teacher's guidance, highlighting the auditory and visual support that tablets provide to these students. This shows the learning as well as the facilitative role of the tablet in enabling their access to more information, vocabulary, and knowledge. Another reason for increasing adoption, as mentioned by Pegrum et al. (2013), is the relative convenience of use that is offered by the tablet, followed by the less time that is required to prepare any content and enable more storage of content for both teachers and students relative to traditional note taking and hardcopies.

In addition to all these beneficial functions, Liu et al. (2015) refer to how the tablet, through interactive lessons, applications, and games, enables practicing lessons for students to develop and improve their communication repertoire as well as their attention, reading, writing, and speaking abilities. Having determined the role of the tablet as a device that is being increasingly incorporated into learning domains, it is imperative to determine its impact in a complex setting, such as a mainstream or inclusive educational setting, with a variety of students with complex communication challenges, specifically NV autistic children. It further necessitates exploring how teachers and facilitators use tablets

as a communication and social skill intervention, along with their established position as instructional guidelines, their knowledge and proficiency levels of students strengths and weaknesses, the differing styles of learning of each student, and most importantly, the right use of a digital tool.

In light of the above literature, it has been assessed that increases in the predominance of autism, as well as technological dedications, have been reported in many studies (Hourcade et al., 2013). Digital technology has been found to contribute efficiently to facilitating SC in autistic individuals (Mintz et al., 2012). Some autistic individuals have significant challenges using and understanding verbal and NV skills. Hence, they have insufficient receptive and expressive verbal and NV skills that are requisite for producing appropriate responses in communication with others and maintaining conversation, along with the appropriate use of NV skills (Demopoulos et al., 2016). Autistic learners can learn through digital technology in a safe, fun, and interactive setting. This is very important for helping them with their speech and nonverbal difficulties, especially when it comes to paying attention and finding their way around other students (Boucenna et al., 2014; Xin and Leonard, 2015). This study aims to explore how the integration of technology can help manage SC challenges in NV autistic students in the Saudi Arabian context.

The following section will reflect on critical analysis to understand the comparison between traditional and technological interventions to improve SC skills in autistic students more effectively.

2.6.4. Preference towards technology over traditional interventions

Moreover, previous interventions used for improving SC skills include primarily intensive behavioural therapies (Shire et al., 2015). These therapies and interventions include PECS, Treatment and Education of Autistic and Related Communication Handicapped Children (TEACCH) (Mesibov, 2018), and VOCA (Everett, 2016). For minimally verbal autistic students, communication interventions include focused playtime intervention (FPI) (Brignell et al., 2018), alternative and augmentative communication (AAC) (Brignell et al., 2018), and interventions that happen in a natural setting. However, researchers have also reported that these interventions and therapies pose limitations in their own respective forms, including the limited applicability of an intervention in a particular social setting, such as homes or schools only, or interactions with specific people only, which can lead to lower motivation to continue with the intervention (Brignell et al., 2018).

Another perspective on the technologically mediated approach is that the communication behaviour is either enhanced or may remain at the same level as other traditional measures like PECS. The findings presented by Flores et al. (2012) indicate that the tablet

can be incorporated as a motivator during snack time or as a facilitative alternative to other means of improving communication behaviour in autistic students. The use of both approaches requires thorough guidance, explicit instructions, and monitoring by teachers to be successful. Once this approach is in place, and the right mix of techniques and devices has been determined for the students, a tablet may serve its actual purpose far better than PECS. Further steps important to include in technologically mediated approaches include more effort in the preparation, storage, and assembling of cards and pictures, and more mobility for both teachers and students from time to time and place to place in a classroom setting.

Prior studies have mentioned reasons for preferring technology over traditional techniques, i.e., the convenience of use, less preparation and execution time, employing fewer resources and materials for learning, and also the improvement in pace of learning by students, in most cases owing to the student's greater interest in and preference for devices like tablets. Relative to this, critics of this perspective have also identified various challenges to the use of the tablet and its execution, such as finding the right application to address a particular challenge, the availability of devices, and the technical requirements to set up a device, which may incur extra time and effort on behalf of the instructors. In addition, directing autistic students is another task, as is making them understand how to use the device in a particular way and to only use the communication programs on the device. Considering these issues, sometimes teachers may prefer traditional techniques like PECS (Kagohara et al., 2010; Sennott and Bowker, 2009).

The preference for technological or traditional interventions is also a preference for learning that is more student-centred or didactic, respectively. Prior studies have mentioned that the use of technology is taken as a more student-centred style of learning and teaching when compared to a more traditional style of didactic teaching, also preferred by developmental theorists (Clements et al., 2003). The distinctive point in these two aspects is shifting the focus of teaching and learning towards students, and considering their preferences and interests as more important than teacher-oriented styles of instruction. Blackwell et al. (2013) mention the positives of having a student-centred approach to learning, which include motivating the students' autonomy, increasing their independence level, and shifting the responsibility more towards the students in the path of learning. However, not all prior studies have compared the learning outcomes obtained through technologically oriented teaching and traditional teaching. Changing the style of teaching may mean that the learning and teaching practices in a classroom setting undergo a considerable number of changes, but this is important if these changes are to benefit students' learning relative to traditional means of teaching.

Therefore, there is no unified consensus on the use and execution of interventions that may produce noticeable improvements in the dynamic domain of the SC skills of autistic students. More insights into the implications of using tablets vs. traditional teaching conditions for improving SC skills in autistic students are required (Carr, 2012). Considering the focus of research on this particular group of autistic students, the following section focuses on interventions specifically for NV autistic students.

2.7. Role of teachers in the execution of digital technology

Various studies have acknowledged the role and participation of teachers as crucial elements of intervention (Casagrande and Ingersoll, 2017). Likewise, they are recognised as the most effective change agent to incorporate educational techniques and strategies (Allmnakrah and Evers, 2020). In a school setting, where there is a configuration of complex processes, learning, education and varying students' needs and challenges, the teacher's role is of utmost importance. Teachers' expertise and quality of instructions determine the effective provision of interventions and other techniques relative to any other controlled setting (Lawton and Kasari, 2012; Chetty et al., 2014). This importance is linked to the various influences they have on the learning and development of autistic students and other learners facing challenges. Teachers' choices and preferences, keeping in mind students' needs and the challenges they face, and their knowledge of the unique learning style of each student, shape the improvement in students and determine the positive results in various dimensions of student's learning (Leadbetter and Fin 2018). Hence, teachers' roles place them in a unique position in the educational context (Zwaigenbaum et al., 2015).

In the realm of technological tools and their functions (affordances), it is important for the executers, i.e., teachers, practitioners, and parents, to understand the innate functions a technology possesses, i.e., its affordance and its educational affordances (Valanides and Angeli, 2008). Furthermore, it is also crucial for teachers specifically to be aware of the cognitive processes that determine the use of those technological affordances (Yoon et al., 2005). Having posited these concerns, Krauskopf et al. (2012) mention that teachers' understanding of the distinction between technological and educational affordances primarily depends on their personal development and expertise. Pertinent to the fact that the educational context undergoes constant reforms globally, Luckas (2015) mentions that teachers' input is substantive in understanding that a new idea is being introduced as a reform, and that it is a further determinant of the training and development opportunities provided to them in order to help them develop new curriculum and content design and understand the appropriate methodologies and materials for teaching students.

The adoption and acceptance of new technological reforms in school are also dependent on the beliefs and attitudes teachers hold towards change and their job. Younie and Leask (2013) explain the importance of teachers' constructivist attitudes towards their job. They state that teachers who hold the belief that their importance as a facilitator will shape students' reasoning and critical thinking will understand the introduction of new developments into education, including digital technologies and techniques to supplement traditional methods of teaching. Moreover, they further use the modern tools introduced by authorities to innovate the instructions and cultivate a learning environment that is more collaborative.

The role of the teacher is also important in determining the successful adoption, use, and implementation of technological tools in learning and teaching. Additionally, several factors shape this choice, including the provision of training and support to enable the effective use of digital technologies for teaching; addressing teachers' stress and fear of the use of technology in teaching; and enabling them to use these technologies along with student-centred pedagogical practices. These factors have been explained by Aytekin et al. (2012), who found that teachers' attitudes towards the use of interactive whiteboards was significantly influenced by their lack of understanding to use the device effectively, despite their positive attitude towards having the technology in the classroom for autistic students. The study hence emphasised the need to facilitate teachers with the provisions and support required to develop their use of the technology. With reference to the Saudi context, Alghamdi (2018) reflects on ten prior studies across 28 schools in five different cities of the KSA and identifies the need for the provision of training and development opportunities. However, Alharbi (2019) states that there is no connection between the availability of devices in schools and their execution being hampered by teachers' inadequate training. For example, the study conducted by Al-jlad (2007) mentions that digital technologies and devices available in classrooms are used by teachers as a facilitative tool for learning. This relates to another role of technology – motivating learning through regular means and by teachers using it as a motivator for students.

Relative to this, a contrary view, the lack of an adequate use of technology, has been reported due to insufficient resource and development provisions in the KSA. Allmnakrah and Evers (2020) argue that there is insufficient clarity on the implementations being promised by authorities in schools to professionally train and develop teachers to further determine the execution of these policies. There should be motivating factors for teachers to adopt and accommodate new educational reforms. Moon et al. (2007) mention that teachers are facilitators of change and they move forward the performance of students and the success of schools as a whole. Therefore, the provision of opportunities to improve

their performance and professional training is crucial. However, Mofarreh (2016) finds that limited training opportunities are given to teachers in the KSA and also that the service training offered is optional for teachers. Alabdulaziz and Higgins (2017) talked about the problems existing in digitally relevant training for teachers to help them develop the expertise to use the technology. The author mentions that these technology-related training sessions are challenging for teachers as they do not always possess the basic knowledge required to use the technology and their workload and schedule limit the time they have for training.

In addition, as mentioned earlier, Alghamdi's (2018) study states that technological tools are not being used adequately due to a lack of knowledge of how to use the devices and the lack of training. There are other factors that also relate to the adoption and use of technology in Saudi Arabia. For example, Alotaibi and Kuk (2011) in their study stated that the gender of teachers is a primary factor that relates to the use of technology and the orientation of teachers to stick to traditional means of teaching. Wiseman et al. (2018) also mentioned that females are more inclined to use technology than males. Critics have posited a different view of the execution of technological projects in Saudi Arabia and declared the inefficiency of the system to endorse teachers as important change agents. For example, Allmnakrah and Evers (2020) mention that among the various developmental initiatives, the Tatweer project in KSA has not produced the expected results for various reasons. These include the lack of coordination and participation by teachers in the development and design of this project and their insufficient training on integrating the objectives of this project into the academic context. Therefore, authorities must monitor and address the underlying challenges carefully through a precise educational strategy that accounts for accurate implementation practically.

The following chapter elaborates on the study's methodology.

Chapter Three: Methodology

3.0. Research methodology

According to van Manen (1990), the methodology of a research study refers to the philosophical framework, the essential suppositions, and overall characteristics of the research perspectives. Kumar and Phrommathed (2005) put forth their view of methodology as a philosophical construct that directs the research process or the foundation upon which research is based. It is further elaborated by O'Leary (2004) that research methodology is a particular set of paradigmatic assumptions used by the researcher to conduct the study. This study aims for an in-depth exploration of the use of digital technologies to enhance SC in NV autistic students in the Saudi context through investigations carried out at three Saudi inclusive schools in two different cities. It considers the teachers' perceptions of the utility of these digital technologies in terms of the social responsivity of primary school autistic students.

To achieve these research aims, the multiple case study approach is adopted, to answer the following four research questions:

- Research Question 1: How do teachers use digital technologies to support the SC of NV students?
- Research Question 2: In what ways do non-verbal autistic students use digital technology for SC?
- Research Question 3: What are the factors contributing to the use of digital technology as a positive learning tool for non-verbal autistic students?
- Research Question 4: What are the barriers and challenges to using digital devices as a tool to support the SC of NV autistic students?

For a successful research methodology, Allan and Slee (2008) and Mackenzie and Knipe (2006) suggest two criteria for researchers to follow, namely the use of relevant research objectives and an appropriate methodology, and a methodology that is replicable for use in future research. As well as being the philosophical foundation of the research, the methodology also highlights the researchers' unconscious views (Creswell et al., 2011). Therefore, this chapter describes the overall research methodology for the collection and organisation of the study data and a justification of the choice of the particular methods being used. Moreover, the chapter also reflects on the philosophical stance of the underpinning research and the rationale for adopting a qualitative multiple case study

approach. The data collection strategies are discussed in detail, including the instruments used, i.e., observation and semi-structured interviews. The chapter also presents the data analysis approach and the ethical considerations of the study.

The secondary purpose incorporated into the research was to collect and compare multiple data - i.e., through classroom observations of student–teacher interaction and semi-structured teacher interviews. The intent is to contribute to the understanding of how the incorporation of digital technologies can help to manage SC difficulties in NV autistic students by looking at multiple cases – in this case, schools in Saudi Arabia. Furthermore, the multiple case perspective enables the exploration of the perceptions of different teachers regarding how the use of technology, specifically tablets, influences NV autistic students' communication skills and social behaviour in the classroom setting. This purpose guided the decision to use two data collection methods: 1) direct classroom observation and 2) semi-structured interviews with teachers. This approach provided the researcher with the ability to build deep qualitative interpretations of the complex digital learning experiences with autistic students who are NV, while also allowing an outcome that can more easily help the teachers and school authorities to enhance their efforts aimed at supporting SC.

3.1. Research paradigm

Each research paradigm carries significant assumptions, beliefs, norms, and values that further reflect particular elements of the paradigm, e.g., epistemology, ontology, methodology, and axiology (Klenke, 2016). Epistemology refers to the nature of knowledge and the comprehension of that knowledge by the researcher, affecting how further knowledge will be explored in the particular social context being investigated (Klenke, 2016). As a whole, it enables the researcher to position themselves within the research context to reflect on new findings and factual evidence (Henry and Foley, 2018). The ontological orientation of the paradigm enables the researcher to address the philosophical and theoretical assumptions linked to the research and how the researcher infers certain meanings from the data (Mayer, 2015). Following this is the methodology, which highlights the overall research design, approaches, and data collection techniques that will be employed in a logical flow to gain knowledge of the research problem being investigated (Klenke, 2016). Lastly, the axiology pertains to the ethical orientations of the research, involving the adoption of appropriate decision-making and research behaviour, avoiding or minimising unwanted actions, and keeping in view extrinsic and intrinsic moral obligations during the research process (Henry and Foley, 2018). The aforementioned paradigm orientations are key to the overall success of the research.

3.1.1 Philosophical position and research approach

Despite knowing the interdisciplinary values linked to qualitative research, the burgeoning dynamics of social contexts, participants, and researchers have not limited qualitative research to a unified or standardised field of theory and practice (Antwi and Hamza, 2015). On the contrary, the subject being researched is always subjected to a plethora of opinions, raising debates among researchers on which qualitative approach will best facilitate adequate data collection, analysis, and presentation. The concept of a 'research paradigm' refers to a set of principles and philosophical ways of thinking that direct the research (Antwi and Hamza, 2015). Presented as a specialised research term for the first time by Thomas Kuhn (1962) in his influential publication *The Structure of Scientific Revolutions*, the paradigm was connoted as 'human construction' and 'reflection of human worldview'. The paradigm enables the researcher to construct meaning from the collected data (Tumele, 2015). The significance of the research paradigm is relevant to assessing the research culture as it relates to the underlying ontological and epistemological beliefs and values being shared by researchers in a community (Antwi and Hamza, 2015).

To establish congruence between the research paradigm and the methodological structure, an assessment of different paradigm approaches is required. Positivism and interpretivism are the two most popular paradigms for thought in the social sciences. Under the positivist framework, one would expect knowledge to be unbiased. According to Guba (1990), positivists view the world as something 'out there', and a positivist is interested in discovering the 'true essence' of reality and how it functions. Researchers operating within a positivist paradigm seek this reality and its consequences in an effort to predict or control phenomena. Positivists are those who, according to Chambliss (1996), think that the same procedures that are useful in natural science may also be useful in social science research. This view holds that the boundaries between the scientific and social sciences do not exist since human behaviour may be predicted, caused, and subjected to observable internal and external influences. Positivists in education research may use statistics and other purely quantitative approaches to test hypotheses and generalise their results in the same way as scientific researchers do (Bryman, 2016).

In the context of this research, a positivist study could collect data on the opportunities and challenges faced by NV autistic students to manage their SC difficulties as experienced by teachers at three different schools, with the goal of drawing broad conclusions through statistical analysis under the 'objective' assumption that the researcher has no personal connection to the subjects of the study. However, it is widely acknowledged by researchers that social and behavioural phenomena are extremely complex; it is limiting to use only

natural science methods, and more attention is needed to explore complex social phenomena in a given context to realise that values, beliefs, and morals in humans are subjective phenomena that consistently affect the research results (Morris, 2006).

Positivist ideas go against the interpretive paradigm, which contends that positivism gives insufficient consideration to social context and human meaning-making and belief formation. Since knowledge is subjective and formed by various interpretations of reality, an interpretive paradigm rests on the idea that there are many ways to understand the world (Scott and Usher, 1996). According to Smith (1993), there is "no special method that automatically leads to intellectual progress and knowledge creation" (p. 120). For the current research, the interpretivist approach complements the exploration of how digital technologies can be used by teachers for NV autistic children in classroom settings by exploring the opportunities and challenges and teacher's experiences with them. This whole context has interwoven elements of human understanding, behaviours, and experiences in terms of using digital technologies for managing the SC difficulties of NV autistic students.

Each research paradigm encompasses significant assumptions, beliefs, norms, and values that further reflect particular elements of the paradigm, such as the epistemology, ontology, methodology, and axiology (Klenke, 2016). Epistemology refers to the nature of knowledge and the researchers' comprehension of that knowledge, affecting how further knowledge will be explored in the particular social context being investigated (Klenke, 2016). As a whole, it enables the researcher to position themselves within the research context to reflect on new findings and factual evidence (Henry and Foley, 2018). The ontological orientation of the paradigm enables the researcher to address the philosophical and theoretical assumptions linked to the research and how the researcher infers certain meanings from the data (Mayer, 2015). According to interpretivism's underlying ontological principles, different people have different perspectives on the same event because they each perceive it through their own unique lenses. An interpretivist ontology for this research would focus on understanding the subjective experiences and meanings attributed to the teacher's experiences of the use of digital technology for NV autistic students.

In this study, the literature review chapter demonstrates the dearth of research on NV autistic students and how their SC can be enhanced using digital tools. This needs to be explored owing to the significance of these characteristics and their link with other life skills and the academic progress of these students. With an interpretivist approach, the researcher aims to explore and understand the social reality experienced by the teachers in different schools in the Saudi context, since there are mixed perspectives on the use of

technology for autistic students. With regard to the NV presentation of these individuals, it is imperative to know the associated phenomena and the underlying philosophies, understandings, and experiences related to managing their SC difficulties. Therefore, the interpretivist ontological approach would link to the importance of exploring teachers' perspectives, acknowledging their role in facilitating SC, and uncovering the nuanced opportunities and challenges that arise within the context of multiple inclusive settings. This approach would seek to uncover the unique social dynamics and interactions that shape the students' use of technology, providing a holistic understanding of the phenomenon.

Relative to ontological stances that rest upon what is out there, epistemology, as elucidated by Robson (2011), encompasses a framework for understanding the process of acquiring knowledge (p. 525). Epistemology is the philosophical highlight, and the justification of the knowledge being sought leads to the selection of the methodology and is a crucial starting point for an effective research stance, irrespective of the quantitative or qualitative nature of the research (Ryen, 2016). Following this premise, the current research correlates with interpretivist epistemology. According to interpretivist epistemology, everyone has their own unique perspective on the world and their own unique way of making sense of it (Maxwell, 1996). Relevant to the context of the current study, interpretivist epistemology was appropriate to gain insight into teacher's perceptions and experiences of the use of technology. Recognising that there would be varying realities, it was necessary to know what it meant at any given point for the participants involved. The interpretive subjective epistemology for this research would allow the researcher to recognise that knowledge is constructed through the social interactions and interpretations of the individuals involved. This would further enable the researcher to explore the social realm of the participants (by interviewing teachers and observing student–teacher interactions to better interlink the study phenomena) with the purpose of comprehending the progress in the SC of NV autistic students, if any, and the elements exerting an influence when they interact with each other. In other words, to uncover the complex interplay between technology, social interactions, and learning within the inclusive school context, providing insights into managing SC difficulties for NV autistic students within a given context. From the theoretical perspective, an interpretivist epistemology would help to devise the underlying research and facilitate researchers' understanding of the processes through which reality is formed.

Cuthbertson et al. (2020) explained the epistemological underpinnings of interpretivism, positing that reality is seen as a product of social construction. Constructivism, being a non-objective approach, considers the construction of knowledge through active

interaction with natural settings and experiences that are further reflected in research (Denzin and Lincoln, 2011). Constructivist epistemology holds the notion that truth and meaning are constructed through meaningful interaction between the researcher and the world and that they do not exist in the external world (Gray, 2013). Hence, being a meaning-making theory, it offers an elaboration of the nature of knowledge and how learning takes place in human beings. Moreover, it serves to connect the researcher's experience and knowledge with what is being pursued through the research process and the cognitive processing of data obtained through interaction with the participants (Creswell and Poth, 2017). It offers a platform from which to assess different perspectives linked to the subject being studied and it also enables the development of understanding through interactions. So, the features of interpretivism point to the fact that social phenomena cannot be understood from an individual point of view; social realities have multiple origins and are socially constructed; interpretivism is facilitated by the researcher's and participant's inevitable interaction; the research context is vital for knowledge generation; the findings direct knowledge generation and are value-based and should be precise; and the contextual factors are interdependent, so there is cause and effect (Kelly et al., 2018). The benefit underpinning this approach is that it has the capacity to develop rapport between researchers and research participants, enabling the latter to freely articulate their own narratives (Yanow, 2017). Hence, in a practical research setting, views of reality can be obtained when participants communicate their opinions, which further enables researchers to better analyse their behaviours.

In the context of the given research, it was crucial to analyse the participants' (teachers') interpretation of reality, as their perspectives and beliefs shape their own social realities. The beliefs held by them shaped their experiences in terms of the opportunities and challenges they face while using digital technology to manage SC difficulties, particularly in a mainstream inclusive setting for NV autistic students. These beliefs are influenced by their unique perspectives, and have major implications for their instructional practices in the classroom. Consequently, these practices have direct consequences for the social environment experienced by the students.

The selection of the philosophical and ontological orientation further strengthens the choice of methodology; a strong relationship exists between the paradigm and the methodology, as it further contains implications for addressing the research questions, participant recruitment, data collection tools, and mode of analysis (Brown, 2017). Thus, the choice of a qualitative multiple case study approach will fit with the interpretivist paradigm, which will further facilitate the social context of the existing discourse of research.

The following section presents the methodology and highlights the overall research design, approaches, and data collection techniques that will be employed in a logical flow to gain knowledge of the research problem being investigated (Klenke, 2016).

3.2. Research methodology: Qualitative approach

Different research designs are employed in different research contexts, but scholars posit that all research designs play significant roles in special education research (Rumrill et al., 2020), although it is important to consider the most appropriate design for addressing particular research questions. Special education researchers further argue that numerous challenges exist when it comes to selecting one design, as there are no universally agreed standards for categorising research designs. Despite these challenges, special education research mostly uses one of two research designs: quantitative, which incorporates numerical data (descriptive, relational, experimental), and qualitative, which examines the research questions using non-numeric data and produces in-depth real-time narratives of a phenomenon (Edmond and Kennedy, 2016). There remains a prevailing implicit attitude among a significant number of research scholars that the outcomes of qualitative research lack credibility. However, it is argued that this disregard of qualitative research is a widely perpetuated misconception, and that rigorous qualitative research is as important as quantitative research (Bolte, 2014). However, the proponents of qualitative research with autistic individuals argue that in order to gain a more comprehensive understanding of the lived experiences of autistic individuals and those in their social circles (such as teachers, parents, siblings, and partners), qualitative research is a valuable approach. This is particularly relevant as it pertains to themes that have received limited attention and are not well understood. When evaluating the significance of qualitative studies, it is imperative to consider the level of methodological rigour employed. van Schalkwyk and Dewinter (2020) highlighted that a qualitative research study of high quality entails the formulation of a well-defined research question, such as investigating the experiences of autistic adults in relation to barriers encountered in accessing healthcare. Additionally, the utilisation of appropriate data collection and analysis methods, such as semi-structured interviews, is crucial. The adoption of an established methodology, such as interpretative analysis, is also essential. Ideally, the researcher should explicitly state their epistemological stance, to enhance the transparency and credibility of the study (Bolte, 2014). Furthermore, it is crucial to possess an understanding and consideration of the requirements of autistic individuals (Anderson et al., 2018). Additionally, involving

stakeholders in the analysis of comprehensive data provided by autistic individuals is of significance.

Pertinent to the current study, the qualitative research design is of utmost interest as it takes a naturalistic approach (assessing things in their natural settings) and is fundamentally descriptive to provide an in-depth description of the phenomenon under study. Qualitative data are known for being basic, holistic, and 'real' (Miles, 1979); however, data collection, transcription, analysis, and the documenting process require highly concentrated, rigorous, and sometimes tedious efforts (Abaeian, 2018). The notable use of a qualitative research design in the special education field is supported by the fact that it helps to produce deep and rich descriptions to address a wide range of topics in a natural setting. For instance, in special education, in an area such as educational settings' adoption of technology and interventions, this approach can gather information about the experiences of teachers and parents regarding the use of technological devices for their students/children or the perceptions and attitudes related to special education services in a particular context.

Hodge (2020) elucidates that qualitative research incorporates five phases: namely the researcher's positionality when confronting ethical considerations; addressing the theoretical perspectives and paradigms (ontology, epistemology) of the research; identification of research methodologies; determining appropriate data collection methods; and qualitative interpretations and evaluations. In further support of the qualitative design, Denzin and Lincoln (2011) argue that it is a rigorous and well-acknowledged form of extensive knowledge generation. The qualitative research design used in this study had two purposes: (1) to assess the overall effectiveness of digital devices being used to address the SC complexities of autistic children in schools in Saudi Arabia; and (2) to assess teachers' perceptions of the use of these devices and their contribution towards improving the SC difficulties of NV autistic children and then to compare data from different methods to reach a concise conclusion.

The assessment of prior evidence has revealed that there are few studies to lean upon when planning a methodological approach for a qualitative study involving children with special educational needs. This calls for numerous questions to be answered, such as: What are the potential criteria for successful involvement of children? How can sufficient involvement of children be accomplished? How can an influential study be planned when the student participants are challenged in terms of their social and communication perspectives? It is known that autistic children who are NV or MV speak very few words, lack appropriate gestures, and avoid eye contact (Pudlo and Pisula, 2018). The different approaches used in this research are in line with the research questions and problems to

obtain the responses and data from different perspectives. The research questions that guided the study are detailed below in Table 2.

Table 2 Set of research questions

RESEARCH QUESTIONS POSED IN EACH CASE	MAIN METHODS OF DATA COLLECTION
Q1. How do teachers use digital technologies to support the SC of NV autistic students?	• Observation (Field notes) • Interviews • Personal reflection and journaling
Q2. In what ways do non-verbal autistic students use digital technology for social communication?	• Observation (Field notes) • Semi-structured interviews • Personal reflection and journaling
Q3. What are the factors contributing to the use of digital technology as a positive learning tool for non-verbal autistic students?	• Observation (Field notes) • Semi-structured interviews • Personal reflection and journaling
Q4. What are the barriers and challenges to using digital devices as a tool to support the social communication of NV autistic students?	• Observation (Field notes) • Interviews • Personal reflection and journaling

As such, this study employs a qualitative methodology to conduct an in-depth exploration of teachers and students' experiences of digital technologies for NV autistic students. The researcher aims to gather detail-rich data narratives that are facilitated by the multiple case study approach, using semi-structured interviews and direct observation in a natural setting.

3.3. Research design: Multiple case study

According to Creswell (2013), the case study is a comprehensive system of analysis that investigates real-life cases, either single or multiple, over a period of time by employing comprehensive data collection methods to generate rich data descriptions and themes. A case study focuses on the 'when', 'how', and 'why'; it is essential to evaluate the behaviour of the study participants when addressing the relevant contextual conditions for the overall research phenomenon (Tetnowski, 2015).

According to Baxter and Jack (2008), the information generated through multiple case studies, multiple sources of information, and different methods allows a broader

investigation of theoretical evolution to address the research questions. Yin (2013) elucidates that multiple case studies are more compelling and more robust through replication of the patterns obtained through the collected data; hence, multiple case studies are designed to corroborate the findings and address theoretical considerations that will enhance the trustworthiness of the findings (Gustafsson, 2017). Moreover, prior researchers have acknowledged the potential for multiple case study findings to be generalised and replicated across multiple settings, as well as the generalisation of theoretical propositions (Yin, 2009, 2014). The intent behind choosing a multiple case study over a single case is that it offers more methodological rigor, enhances the precision of findings, relatability, and stability (Houghton et al., 2015), and also generates more compelling evidence (Yin, 2014).

The comparison between multiple cases provides an insight into the existing theories being explored, overcoming stereotypical concepts of pre-developed ideas and facilitating the exploration of new findings, allowing greater variability, comparisons of relationships, and more chances to develop testable theories (Gustafsson, 2017).Given this detailed context of multiple case studies, the current study adopted an interpretivist qualitative case study approach; with it, the researcher aimed to explore and realise, irrespective of his preconceived notions, the opportunities and challenges experienced by teachers in three different Saudi schools while they used digital technologies to enhance SC among NV autistic children.

Considering these analytic benefits of the multiple case study approach, it is important to employ adequate data collection techniques. In this study, the researcher adopted an interpretivist qualitative approach that goes beyond personal notions and values and intends to take into consideration the multiple views of teachers to disclose their experiences and perceptions of the use of digital devices in managing SC difficulties in NV autistic students.

It is important to note that the choice between single and multiple case studies depends on the research question, goals, and resources available. Both approaches have their merits, but multiple case studies often provide a more comprehensive and robust understanding of complex phenomena. In line with the intent of the current study, there were multiple aspects including methodological and theoretical to support the choice of a multiple case study.

Yin (2009) suggests that the utilisation of multiple case studies might provide contrasting or comparable findings across the studies. By using this approach, the relevance of the data is ascertained (Eisenhardt, 1991). In addition, examining multiple cases using

different methods of data collection certainly adds to the overall research trustworthiness and credibility. The use of multiple cases enhanced the rigor of this research by ensuring that the findings are not simply a result of idiosyncrasies in a single case but are more robust and applicable. The rich insights attained from the teachers in three different schools and the observation of three different settings enabled the researcher to gain a deep understanding of the research problem by examining it from various perspectives and contexts, providing a more comprehensive picture than would have been possible with a single case study. With the high level of rigour in a multiple case study, researchers identify patterns and commonalities across different cases, increasing the potential for the findings to be transferable to a different population or context, compared to a single case study.

The transferability of the findings is not broader but limited due to the reliance on a small sample size of participants in each case (Yin, 2009). This study does not assert that the schools and the participants included in the study are representative of all teachers and schools facilitating autistic students in inclusive contexts in the Saudi setting. Additionally, being a qualitative study, its objective is not to extrapolate the findings to other educational contexts. However, the findings of this study may have relevance and possess some transferable characteristics for schools with inclusive settings, directing their services towards inclusion and digital integration for autistic students and, specifically, updating their teacher training programmes to include more solutions for the SC difficulties of these students.

When performing a comparative analysis of case studies, researchers have the opportunity to contribute to the existing literature by examining the significant impact of both the differences and similarities between the cases (Vannoni, 2015). In the context of the current study, there is a dearth of existing research and no prior research specifically assessing the role of digital technologies in managing the SC difficulties of NV autistic students through a multiple case study approach. This approach helped to highlight the contrasts, similarities, and variations across cases, hence enriching the insights drawn from the research. One widely acknowledged observation is that the evidence generated from a multiple case study is considered to possess high levels of credibility and dependability (Baxter and Jack, 2008). Therefore, the incorporation of various situations facilitates a broader investigation of the research questions and the advancement of theoretical frameworks (Eisenhardt and Graebner, 2007).

3.3.1. Case selection

The adoption of the multiple case study approach calls for making critical determinations, such as deciding on the unit of analysis and deciding what should be the ‘case’. In so

doing, the researcher needs to answer the question that would help him to determine the case. Case selection is imperative, widely acknowledged, and essential for successful case study research (Lewis, 2015). Prior research reveals little variation in how samples are constructed for case studies; this tends to be done by adopting either random or convenience sampling. Gerring and Cojocaru (2016) elaborate that case selection should focus on aspects of retaining credibility and consistency by integrating diverse means of observational evidence and avoiding researcher bias in the selection. In addition, the selected sample should be representative and relevant to the research's intent to serve a specific purpose. Keeping all these considerations in mind, the researcher reflected on various questions prior to the case selection: Do I need to only analyse teachers using technology with NV students? Or teachers in different settings? Or a single case? Finally, after a detailed review of the research questions and objectives, the chosen cases were three different schools. Two of them were located in Riyadh and one in the Qaseem region. The latter was chosen as there is little research on the Qassim region; therefore, this study was an opportunity to assess the integration of technology in that region and acknowledge the use of digital technology for autistic students (Aldehami, 2022).

The units of analysis were the teachers and NV autistic students, as the study aims to explore the experiences of teachers and autistic students in managing the latter's SC difficulties. Since the study aimed to gain an in-depth understanding of the teachers' understanding and experiences of the recent implementation of inclusive education in schools, the choice of multiple schools enabled the researcher to explore and comparatively analyse how the teachers' experiences and perceptions varied.

Another important consideration in the context of this study was that with multiple case studies, they could be compared. There are several practical justifications for choosing a multiple case study. The three different schools were selected to identify robust differences and determine any variation in the way that teachers experienced the use of technology, specifically for managing the SC difficulties of NV autistic students. This motivated the exploration of rich narratives through different educational facilities in two different cities.

3.3.2. Schools

From a comprehensive list of institutes in Saudi Arabia, a total of three mainstream inclusive schools were identified with a specific focus on autistic students. The selected schools were recruited for their relative ease of access, their image and element of national representation (in terms of using technology and the curriculum), and primary schools were selected as early skill development is quite strong in a primary school setting.

The reason primary schools were selected was to focus on students from the primary school age group and the practices being executed with them, as many services and educational practices for autistic students are enhanced at the primary stage. Moreover, the inclusive education policies for education are usually embraced at primary age for this cohort of students. Since childhood is a formative time, many studies focus on primary-aged autistic children. Researchers can learn more about the condition's early signs, behaviours, and obstacles by studying autistic children while they are still developing. Early intervention during primary school age can have a tremendous impact in supporting SC and overall developmental outcomes for autistic children (Bejarano-Martin et al., 2020; Blanc et al., 2021). Moreover, Lee and Shivers (2019) explain that primary school age is a critical period for autistic students to show some acquisition of SC skills and provides a window into several issues and potential avenues for action within the educational sphere, such as the development of targeted educational strategies, ultimately enhancing the support system for autistic children during their crucial formative years (Xanthopoulou et al., 2019). Hence, with these reasons in mind, primary schools were considered the most appropriate context for the study.

The purpose of selecting three different schools in two different cities was to ensure a broader representation and to assess variations in education practice, teachers' expertise and facilities, cultural variances that may intervene with educational practices, and technological integration in different regions. Moreover, the selection of two different regions will help to further develop an understanding of teachers' acceptance of digital technology, influencing how teachers perceive and respond to the needs of autistic children specifically with digital technologies. In addition to this, the selection of schools in two different cities will also allow for determining variance in educational norms, attitudes towards disability, and community involvement in terms of funding allocation and staff development, impacting the overall support system availability and accessibility for autistic students in two different cities.

The Al-Qaseem region, with Buraidah being its capital city, accommodates the greatest diversity of the region, making it the most representative of the overall Saudi population. Approximately 90% of the population is middle class, which may reflect the inequity of provisions, resources, and development opportunities (Alfozan, 2022). The two chosen schools in Riyadh city belong to the Southern Riyadh Office of Education and to the Northern Office, respectively, so as to ensure that the selected sites provide a broad representation of the city.

After the schools were selected, participant selection was conducted on the basis of developing a sound comparison, and an in-depth understanding of each case through the

comparison of their similarities and differences in light of the research objectives and questions. As previously mentioned, opportunistic sampling was adopted for the selection of schools. Two mainstream schools in Riyadh were approached: one in the north of Riyadh, labelled as School A, and the other located in the east of Riyadh and labelled as School B. The third school, labelled School C, was selected in the Al-Qassim region, which is one of the 13 provinces situated in Central Saudi Arabia, northwest of Riyadh.

Both School A and School B from Riyadh city were selected owing to their convenient access for the researcher and to avoid extra time spent commuting. However, the selection of two schools from Riyadh was also motivated by the researcher's personal roots in the city, having grown up there and knowing some of the teachers in the targeted schools. This also facilitated access to classrooms, activities, and resources (technological tools, resource rooms). The choice of School C was motivated by the need to take into consideration a representation of schools, practices, and accommodations in a different city, as the first two schools could not be a representation of the overall study context for Saudi Arabia. With the need for confidentiality in mind, the schools' names were substituted for letters and the researcher labelled them School A, B, and C, accordingly.

Selecting different schools allowed the researcher to obtain multiple perspectives from teachers from different schools and regions of Saudi Arabia, assessing the similarities and differences in how digital technologies were being used for NV autistic students. The three different schools were selected to explore the teachers' experiences and perception of their use of digital technologies with NV autistic students, whether technological resources and support were equally available to these schools in different regions, and to explore the opportunities and challenges that facilitated and limited the use of technology, respectively. The variation between cases helped to develop insights from different perspectives on the underlying issue and to answer the research questions. Furthermore, it also enabled inductive reasoning, as rich patterns of information are used to develop a theory in a qualitative approach that further directs the researcher towards the social construction of realities using text from multiple cases as empirical material.

All the three chosen school contexts were male, mainstream inclusive, primary-level public schools in Saudi Arabia. All three schools were governed by the Ministry of Education (MoE) in Saudi Arabia, as the MoE is the authorised body for facilitating educational institutes with required accommodations, resources, and for devising and implementing policies and educational plans. In addition, the MoE is also responsible for supervising teacher-related facilities and training provisions. All three schools were primary schools. Schools A and B had school principals and a supervisor for inclusive programme supervision, but in School C the school leader supervised the inclusive services and facilities. There were specialised

Resource Rooms in Schools A and B that were dedicated rooms where students received individualised instruction and use specialised technology, whereas in School C support was integrated directly within mainstream classrooms through collaborative approaches. The goal of inclusion in each school was to ensure that students received the necessary assistance while promoting inclusion and participation in the general education environment. Each school had both general and special education teachers but no additional staff or teaching assistants were present at the time of data collection. The details of each school, the participants and the technology used are provided in Table 3.

Table 3 Details of selected schools and participants

MULTIPLE SELECTED SCHOOLS	PARTICIPANTS FOR OBSERVATION AND THEIR SC DIFFICULTIES	PARTICIPANTS FOR SEMI-STRUCTURED INTERVIEWS	TECHNOLOGY USED
CASE A: SCHOOL A (NORTH OF RIYADH)	Three autistic students between 6 and 9 years old (two NV with no speech and language abilities, and one MV)	Four teachers in total with experience of teaching autistic students aged between 5 and 12 years old	Tablets to meet the specific needs of each student
CASE B SCHOOL B (EAST OF RIYADH)	Three autistic students between 6 and 9 years old (two NV and one MV)	Four teachers in total with experience of teaching autistic students aged between 5 and 12 years old	Tablets to meet the specific needs of each student
CASE C SCHOOL C (QASSIM)	Three autistic students between 6 and 9 years old (two NV and one MV autistic student who could express some feelings and say a few words)	Three teachers in total with experience of teaching autistic students aged between 5 and 12 years old	Tablets to meet the specific needs of each student

3.3.3. Participants

A detailed review of existing research indicates that teachers play a pivotal role as the primary mediators in facilitating good educational practices and the successful implementation of educational resources. In relation to the incorporation of digital accommodations and the integration of technology, teachers' understanding and perceptions as well as their experiences of managing students with social and communication challenges, have an influence on their instructional methods. Furthermore, these factors serve as a reflection of their inclination to utilise digital technologies (Albion et al., 2015; Van Der Steen et al., 2020; Alhumaid, 2021). Hence, in accordance with the

objective of the present study, teachers were deemed to be the most suitable source for obtaining comprehensive information for this particular case study. This is due to their direct engagement with NV autistic students and their involvement in the integration and application of digital technologies within their instructional practices on a daily basis across all three schools. Hence, the involvement of educators was deemed significant in this study, as their contributions helped to attain a comprehensive awareness of the potential and problems associated with utilising digital technology to address difficulties with managing SC issues.

A total of 11 teachers from all three schools who knew how to use technology and teach autistic students were approached, out of which the participant teachers volunteered to be part of the research This sample was determined via opportunistic, sometimes called convenience or accidental, sampling (Tyrer and Heyman, 2016). The schools were easily accessible for the researcher and the sample selected was an easily accessible pool of respondents who were willing to participate based on their proximity, accessibility, and convenience (Obilor, 2023). While reporting the research, the identity of each participant was concealed to maintain anonymity and confidentiality. The participants' responses in the research report are coded with pseudonyms: "Teacher 1", "Teacher 2", "Teacher 3", etc. The questionnaire contained a section to record the demographic data of the teachers (age, gender, educational qualifications, teaching experience at autistic schools, and level of technology training). All the interviews were audio-recorded, and before the interview session, participant teachers were fully informed about the process, and their consent to volunteer for the interviews was obtained.

In addition, for the observation element of the research, a total of nine MV/NV autistic students were observed from the three schools. The inclusion criteria for the student participants were that they should be aged between 6 and 9 years of age, and have either MV/NV autistic characteristics. All of the participating students were male and part of the special education facilities that involved support rooms for autistic students in mainstream schools. The participating students were recruited by the school leaders and teachers during the consultation, and the consent of their parents was obtained. The recruited students were either NV or MV, with each one exhibiting variations in behaviours and expressive language.

3.4. Data collection methods

The effectiveness of data collection methods is of significant importance when it comes to collecting data about young autistic children in the special education context. Fayette and

Bond (2017) agree that the mechanisms, processes, and perceived effectiveness of the methods used to obtain information about young autistic children and monitor their progress in an educational setting, specifically in qualitative research studies, are crucial. Prior studies in this context have elicited that there are potential difficulties with data collection from autistic students as participants in a study (Fayette and Bond, 2017; Winstone et al., 2014). Therefore, to overcome the potential limitations, it is essential to select the most effective and compatible data collection methods when developing approaches to actively assess autistic students' progress in research (McLaughlin and Rafferty, 2014).

Before selecting a data collection method, the approval of the institutional review board is mandatory (Latunde, 2016). For the current study, the required approval was obtained for data collection through direct observation of autistic children to monitor their progress in the classroom (McFerran et al., 2016; Weisblatt et al., 2019), and for semi-structured interviews with the participating teachers to assess their perceptions of the effectiveness of digital technologies in improving the SC difficulties of NV autistic students. The data collection methods were tailored to gather the best possible information to address the research questions. Observation allows more contextually based assessment of autistic students' progress, learning, and responses while using tablets (Weisblatt et al., 2019), and it can be used on its own or in combination with other progress monitoring methods (i.e., document analysis).

3.4.1. Direct observation

Observation is a potential data collection method that further entails the processing and analysis of rich information that cannot be studied in a contrived clinical or laboratory setting (Glazeir, 2019). In terms of the characteristics of observation, Portell Vidal et al. (2015) assert that observations facilitate a reliable analysis of behaviours and interactions in natural contexts. Observations offer a flexible yet rigorous approach that involves the researcher's perception and interpretation, aided by their previous knowledge and excluding any bias, as explained by Mucchielli (1974). Prior evidence on using direct observation in the special education context reveals three purposes: examining the social and academic learning patterns of individuals; improvement in desired behaviour over time; and research to establish a meaningful relationship between study variables. In this context, different strategies were incorporated to conduct an observation of classroom activities and to record interactions and behaviours and take notes of important patterns (Lewis et al., 2014). The following objectives were pursued while conducting direct observation of teachers and their interaction with NV autistic students (Table 4).

Table 4 Research objectives

NO.	OBSERVATION'S RESEARCH OBJECTIVE
1	To investigate how teachers used digital technologies with NV autistic students to help them manage their SC difficulties. To accomplish this, it was observed which instructional and other strategies (individualised or group) teachers incorporated into practice to engage NV autistic children to help them with their SC skills (joint attention, social engagement, and communication skills). To assess the teacher's proficiency and attitude (tone and repetition of instructions) while using tablets to help students cope with SC challenges in an inclusive setting.
2	To examine how NV autistic students used digital technologies as an interactive tool for their SC.
3	To assess any changes in the SC skills and responsiveness of autistic students, and other positive contributions to learning with the use of digital technologies.
4	To explore any challenges and barriers that teachers face and that potentially limit the use of digital technology in addressing the SC difficulties of NV autistic students.

3.4.1.1. Phase 1: Pre-observation session (preparation)

Before conducting observations, an important aspect was preparing teachers for the observation session and, later on, for a semi-structured interview. For that, the researcher visited each school before the actual observation procedure to inform teachers about the aim of the study. Information sheets (see Appendix 1D) were distributed to school leaders and volunteering teachers to inform them in detail about the observation session and to familiarise them with the process. Moreover, during this pre-observation phase, meeting with the teachers and becoming familiar with the students was a fundamental step to enhancing familiarity with the study participants.

- ***Observation tool***

An observation sheet was developed to record and evaluate teacher–student interaction while using technology (see Appendix 1D). This observation sheet was intended to record pertinent details that indicated that the teachers were using adequate instructional strategies to help NV autistic children (with no or limited speech and language abilities)

with the use of tablet computers for their SC challenges. This also included consideration of teachers' attitudes and skills while using tablets and how proficient they were in engaging students to further work on their SC . In addition to the observation sheet, the researcher kept another observation response sheet in their log to record other important aspects during the observation sessions.

- ***Field Notes***

Field notes are commonly advocated in qualitative research as a method of recording essential contextual information (Phillippi and Lauderdale, 2018). The author's overall assessment of the schools with the corresponding field notes served to enhance the information gathered through interviews and observation, so strengthening the credibility of the study through triangulation (Johnson et al., 2020). Commencing from the second week of the data collection process, the researcher undertook daily observations of the teachers and students' interactions in general classrooms, resource rooms, and break-time activities with prior permission from the school's leader. The primary attention during this period was directed towards the different activities during which technology was used to enable SC in NV autistic students; an examination of the strategies that teachers employed to manage these students; the classroom layout; and other available technological accommodations and resources. The researcher made detailed observations of the use of the available technological tools, the ways that teachers used them, and how students used them to interact and communicate when needed within the natural classroom setting. Pertinent information, such as difficulties that teachers faced while using technology, any behavioural challenges exhibited by students while using technology, and the behaviours shown by teachers during their interactions with autistic students, were recorded (Cohen et al., 2007). Field notes were carefully recorded on a regular basis during the researcher's stay at each school during each observation session, and the field notebook was constantly updated during that time.

3.4.1.2. Phase 2: Conducting observations

A total of six observation sessions were completed for each school. Each targeted school was visited three times on alternate days (two consecutive weeks to observe the classroom, along with resource rooms and the break-time learning activities of targeted participants during each observation session). Having each observation on a different day allowed more time to focus on each; this decision also facilitated the addition of notes later on during the day. The observation sessions yielded detailed narratives and in-depth notes of different intervals spent on different classroom activities and sessions. This allowed the

researcher to document the students' learning, and the interaction with teachers and digital technologies, recording different activities in the different contexts of the classrooms (time spent on breaks, engaged in educational activities). Visiting hours were allocated as per the consent of school leaders and classroom teachers, i.e., 9 am to 11 am.

The observation schedule of the students shown in Appendix 1D(a) and the teachers' observation schedule shown in Appendix 1D(b) were used to document the field notes. The pre-designed schedule helped the researcher to keep a record of important events and later comment on important behaviours and interactional cues to be corroborated with findings from other methods. The purpose of this observation was manifold, and it helped the researcher to focus on and observe specific aspects in the classroom, for example: the teacher's role in using the digital technology in different classroom activities; how the students used digital technologies to interact and communicate their needs and wants; assessing the expertise of the teacher in using the technology for different activities and different situations such as group time, one-to-one activities, break/lunch, and reading time; how the teacher instructed the child during the everyday classroom routine; and the engagement of both teachers and students with the technology. The researcher recorded different details of activities in the classroom, thus allowing further data themes to emerge. Observation of classroom activity in this way allowed reasonable and cross-sectional analysis of activities in the classroom setting.

Some of the observations were conducted in the resource rooms as mentioned, as Schools A and B have separate resource rooms or support rooms. These supported rooms were designed for those with special learning needs, including autistic students. School A had a sensory room especially designed for autistic students with special lights and soundproofing arrangements. In school B, the resource room was locked and one of the teachers mentioned technical issues and another reported the lack of assistant teachers in that room. School C did not have a designated resource room but a separate space within the mainstream setting with other students. During the observation sessions, it was recorded whether the teachers were using those rooms with their autistic students.

A reflective style of field notes was adopted that recorded different categories of data on each page of a predesigned schedule, including explicit interaction activities between the teacher and NV student, the strategy being used with the technology, how much each student interacted or paid attention, classroom ambience and layout, and duration of the interaction. Moreover, observations of the teacher's tone, attitude, and repetition of instructions were also made to highlight their mediatory role with the student. A 'to-do'

list was made at the bottom of each note to gather information about a particular activity during the interview sessions.

In this way, the observation was conducted to obtain background on shared experiences between the researcher and the participants, and later this enabled discussion of specific incidents with the teachers during the interview sessions. This further enhanced in-depth exploration by concentrating on real and shared events rather than assumed reconstructions (Cotton et al., 2010). As a whole, the observation sessions served as a means of determining the teacher's role in terms of how they used technology to enhance the SC skills of their autistic students.

3.4.2. Observation setting

Direct observation was adopted for data collection, i.e., a natural classroom setting was considered, as many special education researchers view this as a powerful mode of observing the participants relative to more contrived modes and settings (Cohen et al., 2013). Coupled with observation sessions, the use of a natural setting approach allows the observation of an event or series of events in a natural setting and is recorded by an independent researcher (Glazier, 1985). It is also a flexible approach as the researcher can determine the length of the observation sessions.

Each of the mainstream schools had self-contained classrooms where autistic students had access to interactive learning tools to manage their challenges. Thus, being in a natural setting (i.e., a classroom) allowed the researcher to take notes on the various elements of students' learning that were taking place in a context in which the student was expected to perform the targeted skills (Watkins et al., 2019). Also, observation in a natural setting enabled the researcher to observe the participant students as they exhibited their particular challenges/behaviours, due to the flexibility of longer observation periods (Glazier, 1985).

Some classrooms had additional devices such as smartboards, but primarily a tablet with a protective shield with attached handles was provided to the students. Speech-generating applications and interactive games were installed on each tablet. For consistent ease of access, icons of the learning applications were placed on the home page of the tablet. Teachers used these icon buttons to open the next page that contained further appropriate pictures and icons to open the desired programs. A gender-appropriate voiceover was an in-built feature of the applications, and each button produced either a word or a complete sentence as per the command pressed by the user. For example, on a page containing numbers, pressing the number 5 resulted in an utterance of the word 'five', and on the page containing buttons and images of fruit, the tablet said 'I want an apple' (see Appendix

2). Hence, each button contained vocabulary words for the students to learn. The applications also had customising features, where icons could be adjusted according to the sensory sensitivity of the child (adjustable fonts, brightness, voice type, dictionary, and text highlighting), vocabulary words could be changed as per the lesson requirements, and the proficiency level of each student could be set. An example is provided in Table 5 below.

Table 5 Overview of application 'context' button

	APPLICATION 'CONTEXT' BUTTONS				
VOCABULARY WORD OPTIONS	**NUMERICS/ MATHS**	**DAYS/ACTIVITIES**	**SOCIAL CUES**	**I NEED**	**FRIENDLY BUTTONS**
	0	Monday	Fun	Food	Hello
	1	Tuesday	Clown	Tablet	Bye
	2	Wednesday	Circus	Break	Let's play
	Add	January	Dance	Sleep	Friends
	Subtract	February	Walk	Help	My turn
	More	Home	Bus	Home	Your turn
	Less	Park	Train	Teacher	Thanks
	Same	Sunny	Horse	Book	Please
	Done	Rainy	Lion	Glass	I am sorry
	Yes	Yes	Yes	Water	I am good
	No	No	No	More	Please

After the observations were completed, semi-structured interviews were conducted to explore the teachers' perspectives and attitudes towards the effectiveness of using tablets to support the SC skills of NV autistic students. The teachers were interviewed after each observation session in their relative schools. A set of standard open-ended questions was formulated and posed to the teachers after each observation session. The teachers were allowed to reference their views, progress reports, and other records when answering the questions.

3.5. Semi-structured interviews

The interview method of data collection was selected for the current study because of its widespread adoption in a qualitative research context (Bedoin and Scelles, 2015). Semi-structured interviews were used to explore the teachers' input, experience, and expertise as a means of assessing the role of technology in their teaching. An in-depth semi-

structured interview protocol was designed with open-ended questions. According to Allan and Slee (2008), semi-structured interviews are the most appropriate approach to use when conducting inclusive educational research to extract data that is relevant for such a study. It has been argued by Pathak and Intratat (2016) that the semi-structured interview offers a more flexible platform for conducting interviews and enables probing of more in-depth data through participants' responses. Also, Brinkmann (2014) states that semi-structured interviews allow for detailed interviews in which the respondents can answer predetermined open-ended questions, and they are extensively used by healthcare professionals in their research.

The interview research objectives were to:

- Explore teachers' opinions and perceptions towards the effectiveness and use of digital technologies for supporting SC in NV autistic students.
- Explore teachers' experience of students' SC difficulties and the manifestation of their progress at different levels of learning.
- Assess teachers' proficiency and knowledge of the use of digital technologies and their views on any positive contributions made by these technological accommodations.
- Explore teachers' perspectives on any challenges or barriers to using digital technologies for the SC of NV autistic students.

3.5.1. Practicalities of conducting interviews

Numerous practical implications must be considered when conducting qualitative research interviews, particularly in the special education context (Mangafa et al., 2015). Pertinent aspects include deciding on an appropriate time for the participants to be interviewed, allowing ample time to prepare for the interview, deciding on the adequate length of the interview session, and determining the potential methods of recording interviews, for example, voice recording, note taking, etc. Mintz (2013) states that pre-evaluation of such factors adds to the effectiveness of the interview session, and also pre-reflection on the different interview processes will help to determine whether any changes are required. In addition to these details, it is also imperative to consider the interviewer's characteristics for successful interview execution and potential data and information generation. For instance, the interviewer should be well acquainted with the interview guide and process (DeJonckheere and Vaughn, 2019), should exhibit patience when listening to the participants' responses (Sedorkin, 2020), and demonstrate an open and empathic attitude during the session (DeJonckheere and Vaughn, 2019). Moreover, pertinent to the context of the current research study, the researcher should possess a clear understanding and

knowledge of the autistic students, their characteristics, their learning challenges, and especially their SC levels. Another important element for an effective semi-structured interview session, according to Ayres (2008), is carefully considering the timing of the interviews; they should be no less than half an hour but no more than one hour. This recommendation was followed in the current study, and each interview lasted for between 45 and 60 minutes. Kallio et al. (2016) emphasise that the rigorous development of a qualitative semi-structured interview is fundamental to maintaining the trustworthiness of the research and contributes to the plausibility of the findings. Researchers should consider using the following step-by-step process to develop a semi-structured interview to justify its format.

3.5.2. Determining the prerequisites for employing semi-structured interviews

The current study context allowed exploration of the diverse perceptions of teachers using a semi-structured interview method, which was suitable for studying teachers' perceptions and opinions on the use of tablets. These were corroborated with the observation findings.

3.5.2.1. Formulating the preliminary semi-structured interview format

This entailed the use of a tool for interview data collection, namely a list of questions (a main theme and follow-up questions, using previous knowledge regarding structural and logical content, and a flexible structure to the questions, allowing two-way dialogues between the researcher and the participant teachers). The theme of the interview questions was based on the research questions and research objectives. The research design ensured that the interview questions were developed in such a way that the respondents were able to give detailed answers relevant to the research questions; the questions were easy to understand and free of any bias from respondents (Bryman, 2008); the content of the questions was comfortable to discuss; and most of the questions were focused on 'how' rather than 'why' to keep the interaction with the interviewees friendly (Yin, 2009). To keep the interviews simple for the respondents, all of the questions were translated into Arabic and back to English by adept native Arabic speakers. The interviews were audio recorded and then transcribed. The data collection was impacted by the COVID-19 pandemic period; therefore, a few interviews were conducted online through Zoom and Skype applications, considering the availability of the participants. The online interview session was designed in a way that facilitated two-way communication. As the researcher had met the participants personally prior to the interviews, i.e., during the observations, , it was easy to develop a rapport with them. The questions for the online interviews conducted during pandemic period were also framed same as used for face to face

interviews to support the conversation, save time and encourage rich details in the description. The online interviews were audio recorded and transcribed later for data analysis.

3.5.3. Documents and artefacts (students' files)

the same

Documents and artefacts are resources that may contain important information and details regarding the study participants (Coffey, 2014). Denzin (1970) described document analysis used in combination with other qualitative methods to facilitate further triangulation – the combination of different research methods addressing the same research phenomenon (p.291). During the data collection method, student files and reports were requested with the consent of teachers and parents to access important details of the student's academic records. These documents enable the researcher to access the evidence of the past and then later compare it to the students' milestones they had accomplished during the school activities that were utilised for data analysis.

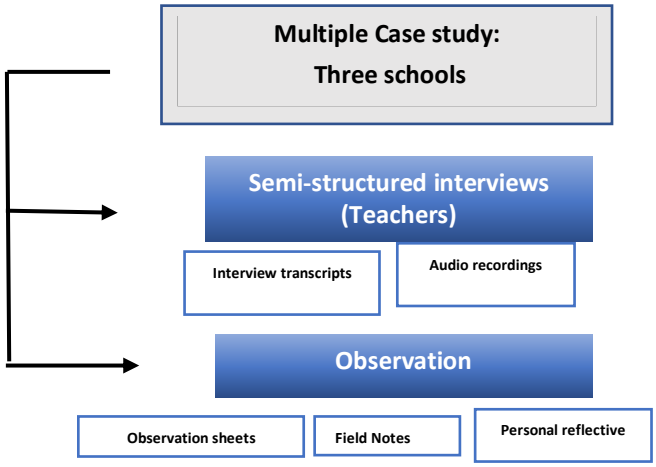


Figure 3 Data collection methods

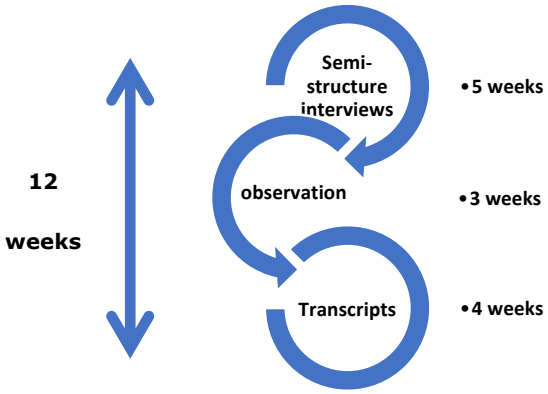


Figure 4 Sequence of data collection

3.6. Data analysis

Following the collection of the data, the subsequent phase in the research process involved deriving meaning from the unprocessed data (Cohen et al., 2007). The process of data analysis started concurrently with data collection; it involved transcribing interviews and typing up the field notes obtained through observations and document reviews (Creswell, 2014). However, the process was not straightforward, owing to the diverse and intricate nature of the qualitative methodologies employed. The analysis encompassed a thorough examination of data, including the identification of emergent themes, and the explanation and interpretation of research data, in order to gain an in-depth comprehension of the perspectives and perceptions of the research participants of the use and role of digital technology in managing SC difficulties.

According to Creswell (2013), there is no unique method for conducting data analysis in qualitative research. However, one commonly employed strategy is thematic analysis, as highlighted by Bryman (2016). Thematic analysis is a methodology that involves the identification, analysis, and reporting of patterns, often known as themes, within a given set of data (Braun and Clarke, 2006, p. 79). The six phases of thematic analysis proposed by Braun and Clarke (2006) were employed in this study, as seen in Table 6. However, it is important to note that these phases were not strictly followed in a linear fashion, since there was some iteration and movement between phases during the analytical process. Thematic analysis was selected as the method for analysing the semi-structured interviews and observation data due to its alignment with the theoretical underpinnings of the study. Braun and Clarke (2006) claimed that thematic analysis establishes a connection between individuals and the social context, as data is representative of not just the opinions and ideas of individuals, but also the contextual factors that shape their experiences. Thematic

analysis is situated within the theoretical framework of this study, specifically within the contexts of interpretivism and social constructivism. These theoretical perspectives propose that individuals' perspectives are influenced by the context in which they are situated.

The initial phase encompassed the arrangement of the data obtained through various collecting methods, such as the transcription of the interviews and the typing of the field notes. Additionally, this process encompassed the translation, categorisation, and organisation of data into various kinds based on the origins of the information. The objective was to adequately prepare oneself and become familiar with the data in order to facilitate analysis (Braun and Clarke, 2006; Creswell, 2014). This stage was also accompanied by the translation of the data findings. There is a prevailing argument that language plays a crucial role in qualitative research, prompting certain researchers to raise concerns about the translation process that occurs when data gathered in one language is analysed in another (Mellinger and Hanson, 2016). Language proficiencies play a crucial role in effectively conveying participants' views, behaviours, and perceived notions, hence enhancing their proficiency in the context of data organisation and the consequent steps of data analysis (Vaismoradi et al., 2016).

Consequently, the data obtained in Arabic from the interviews and observations underwent a process of re-examination, followed by translation into English. This facilitated enhanced interaction and familiarity with the material. The correctness of my translation was afterwards verified by member-checking by a colleague proficient in Arabic from the University of Bristol. During the progression of transcription and translation, I identified noteworthy initial codes that were both novel and pertinent. The whole procedure, encompassing the transcription and translation of all the data, proved to be a laborious and time-intensive endeavour. Nevertheless, it is important to note that this period of time was not unproductive. As Braun and Clarke (2006) have elucidated, each of these activities serves as a preliminary step in the process of analysis, contributing to the development of a comprehensive understanding of the data.

The second phase entailed comprehending the collected data and contemplating its overarching meaning. The approach entailed making sense of the data by establishing connections between them and the study objectives, existing literature, and pertinent theories in order to identify the preliminary concepts (Creswell, 2014). At this stage, the researcher recorded the thoughts that arose throughout the examination of the transcribed interviews and observations. The notes were created using Microsoft Word in order to facilitate the process of developing ideas and providing explanations for them.

Table 6 Approach to thematic analysis by Braun and Clarke (2006, p. 87)

STAGES	PROCEDURES
1. Organisation/preparation of data findings	• Organised data from each source (i.e., semi-structured interview transcripts, observation sheets, students' files, reflective journals and personal notes, and transcripts of audio recordings) • Further subsets of each data source were created according to data type/source type and groups • All audio recordings were transcribed Reviewed both audio and visual data for relevance and discarded unnecessary readings
2. Familiarisation	• In-depth reading and review of data findings from all sources • Reflexive analysis and memo noting of important points in the logbook to determine data analysis
3. Developing initial codes	• Multiple phases of coding result in a first and second cycle of coding information • Inductive approach for coding data • 1st cycle codes: initial assessments of collected data findings in accordance with themes that emerge. • 2nd cycle coding: more specific, focused examination and interpretation of the data with a reorganisation of findings. Revisiting all sub-codes
4. Searching for themes	• Collated codes into potential themes, • Assembled relevant data into each potential theme

5. Analysing themes	• Revisited all themes and subthemes • Refined repetitive or similar themes
6. Generating report	Final analysis and write-up of the report
7. Cross-case analysis	• Organised and highlighted distinguishing features and attributes of each case analysis as well as common similarities • Corroborated each difference and similarity of cases against research questions • Merged overlapping findings from each case • Developed memo on emerging themes

The analytical technique proposed by Braun and Clarke (2006) consists of three phases. The third phase entails the generation of initial codes. Braun and Clarke (2006) further elaborate that researchers have the option to employ either an inductive or a deductive approach to uncover the themes.

The inductive approach (data-driven) to coding is employed to search for patterns in order to identify and analyse themes derived from the researcher's data (Roberts et al., 2019). Conversely, a deductive approach is advantageous when the objective is to concentrate on a specific aspect of the data or to gain a deeper understanding of a particular finding within the framework of existing literature (Braun and Clarke, 2006). Inductive methodologies prove to be highly advantageous when venturing into unexplored areas, and qualitative researchers still have a great deal of unfamiliar terrain to explore (Clarke and Braun, 2015); hence, based on familiarisation with the data, an inductive approach to coding was used and themes were developed through comprehensive engagement with the data (Braun and Clarke, 2023).

Initially, the codes pertaining to the existing literature were identified and emphasised. Subsequently, further codes that appeared, but were not connected to the preceding literature, were incorporated. A handwritten mind map was generated at this juncture, organising the data by labelling them to represent the many features that emerged from the preceding material. The process entailed the examination of the participants' responses obtained through the interviews, utilising the transcripts, audio recordings, and field notes derived from the observations. This was done in order to develop sub-themes,

as outlined by Creswell (2014). The facts were visually emphasised through the utilisation of several font styles and highlighting colours. The utilisation of font colours served the purpose of distinguishing the replies of the participants in relation to each study question, as well as indicating field notes pertaining to a specific case. The subthemes were subjected to a comparative analysis and subsequently integrated to form the primary data themes. Figure 4-4 depicts the data points derived and the identified new themes These were: 1) teachers' approach to using digital technology with NV autistic students; 2) students' preference to communicate and socially interact with digital technology; 3) the contribution of digital technology to teaching and learning; and 4) the challenges and barriers to the use of digital technology.

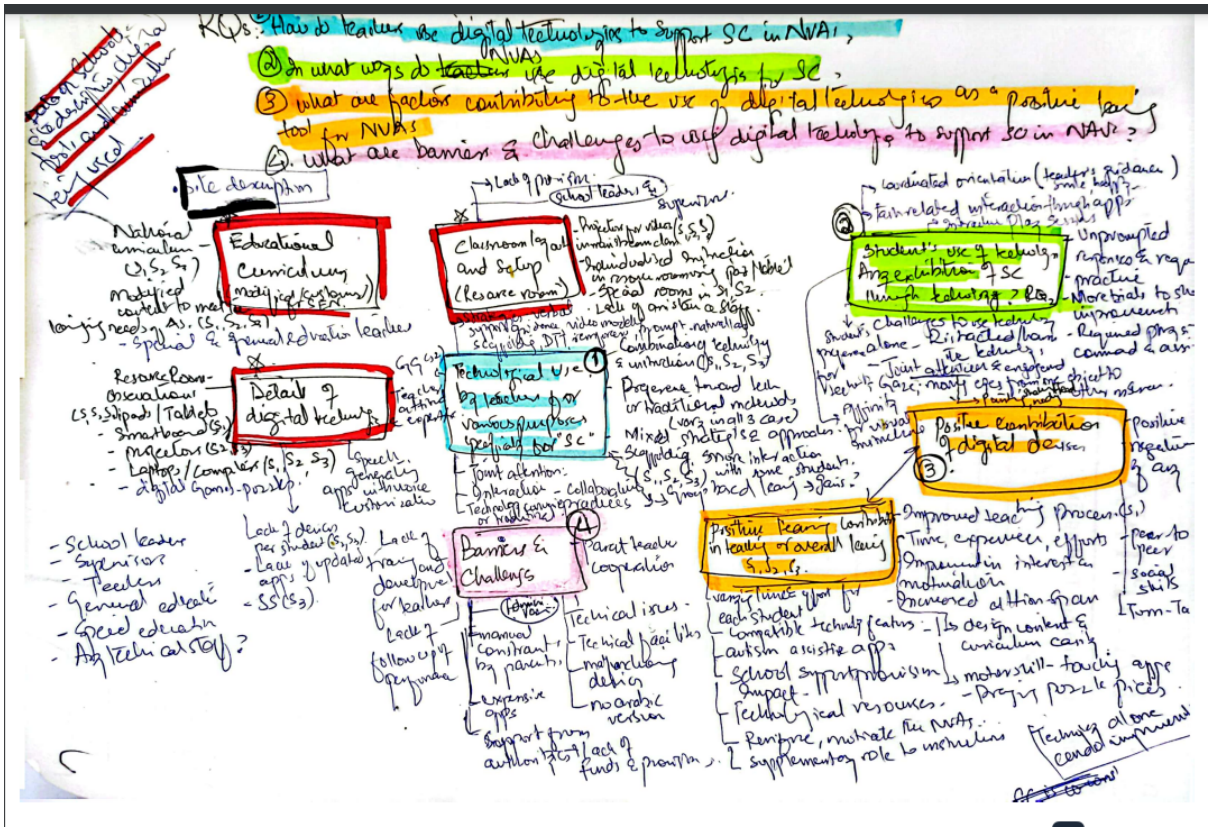
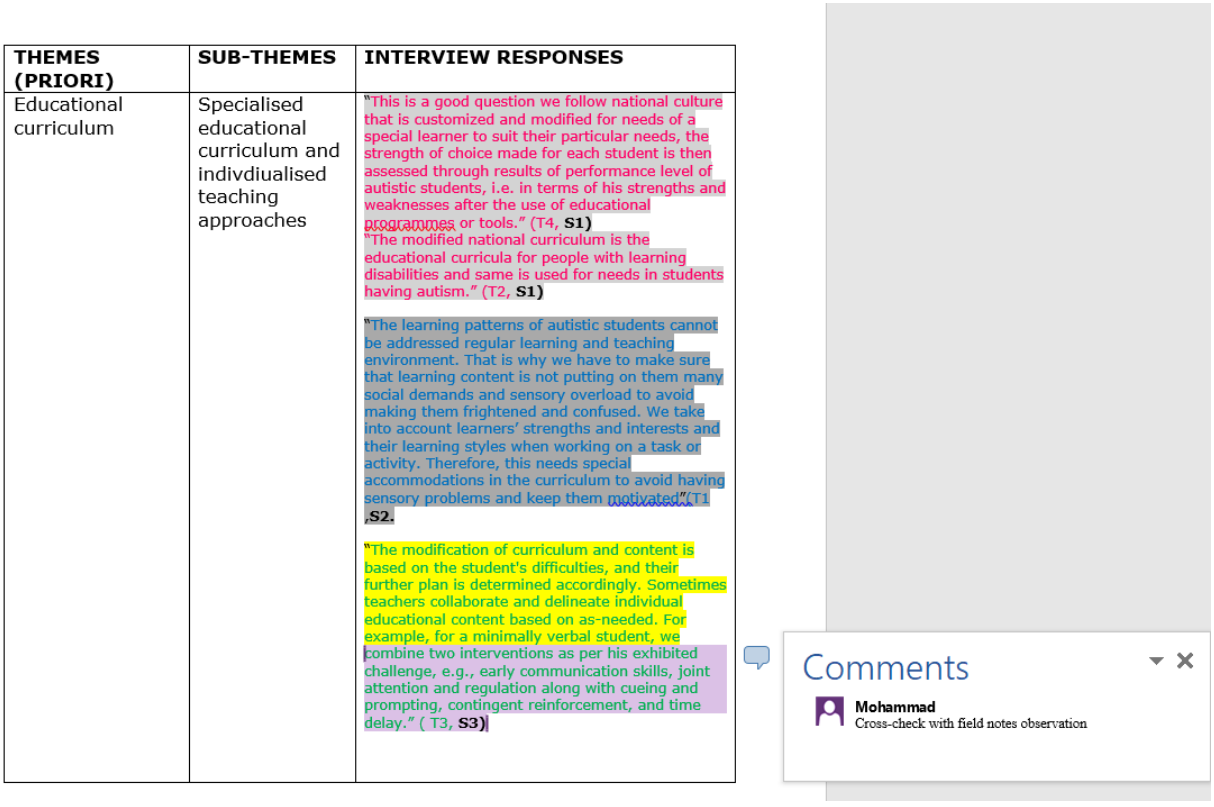


Figure 5 Handwritten mind map of themes

The third stage of the process was the organisation of the data through the use of appropriate labels. The process entailed an examination of the participants' replies obtained through the interviews, as well as the field notes gathered from the observations in order to produce sub-themes (Creswell, 2014). The details were highlighted by utilising

various fonts and colours, which were manually recorded through handwritten notes. The utilisation of font colours served the purpose of distinguishing the responses of individual participants from various schools, as well as indicating relevant areas in field notes for cross-referencing the data. The subthemes were subjected to a comparative analysis and subsequently integrated to form the primary data themes. The procedure of evaluating and consolidating the sub-themes was conducted by considering their similarities and differences, as well as their relevance to the research questions. In contrast to the perspectives presented in the literature (e.g., Braun and Clarke, 2006; Creswell, 2014), the following interview transcript serves as a demonstration of the coding procedures applied to a priori theme (proactive themes developed by utilising a theoretical framework, interview questions, or prior knowledge through a literature review (Kings and Brooks, 2018)) pertaining to the educational curriculum.



THEMES (PRIORI)	SUB-THEMES	INTERVIEW RESPONSES
Educational curriculum	Specialised educational curriculum and indivdiualised teaching approaches	"This is a good question we follow national culture that is customized and modified for needs of a special learner to suit their particular needs, the strength of choice made for each student is then assessed through results of performance level of autistic students, i.e. in terms of his strengths and weaknesses after the use of educational programmes or tools." (T4, **S1)** "The modified national curriculum is the educational curricula for people with learning disabilities and same is used for needs in students having autism." (T2, **S1)** "The learning patterns of autistic students cannot be addressed regular learning and teaching environment. That is why we have to make sure that learning content is not putting on them many social demands and sensory overload to avoid making them frightened and confused. We take into account learners' strengths and interests and their learning styles when working on a task or activity. Therefore, this needs special accommodations in the curriculum to avoid having sensory problems and keep them motivated."(T1 ,**S2.** "The modification of curriculum and content is based on the student's difficulties, and their further plan is determined accordingly. Sometimes teachers collaborate and delineate individual educational content based on as-needed. For example, for a minimally verbal student, we combine two interventions as per his exhibited challenge, e.g., early communication skills, joint attention and regulation along with cueing and prompting, contingent reinforcement, and time delay." (T3, **S3)**

Figure 6 Example of sub-theme generation based on a transcribed interview from all three cases

Relative to this, emergent themes were also generated during interview data collection and observation sessions. Figure 6 exhibits the coding of an emergent theme arising from data collection across all three cases.

3.7. Trustworthiness

In their study, Nickasch et al. (2016) explored many aspects related to trustworthiness. The trustworthiness and integrity of qualitative research, as well as the transparency in the execution of the study, are essential to the use and quality of its findings (Cope, 2014). The criteria established by Lincoln and Guba (1985) have gained widespread acceptance among qualitative researchers and were considered to assess the trustworthiness of the current study including the measures of credibility, transferability, and confirmability,

The most crucial element of trustworthiness is the research's *credibility*, or the degree to which the results can be trusted as being accurate. The credibility of this research was ensured by triangulation using multiple methods of data collection, as defined by Bryman (2016). This involved using several data collection techniques to better understand the social phenomenon under study. The research relied on data gathered through a combination of semi-structured interviews and participant observation, using personal journaling, filed notes and audio recording (Yin, 2009).

The iterative questioning of the data, whereby the data are revisited and analysed several times, is crucial to ensure the credibility of a study. Another strategy that may be utilised to enhance the credibility of the research is peer debriefing or member checking, as suggested by Earnest (2020). Member checking, often referred to as participant or respondent credibility, is a methodological procedure wherein the collected data or findings are shared with the participants, in order to verify the accuracy and significance of their narratives, as well as the alignment of the emerging concepts with their own experiences. The primary objectives of this procedure are ascertaining the extent to which the participants' reality is accurately portrayed, facilitating opportunities for error correction, evaluating the researcher's comprehension and interpretation of the data, and affording participants the chance to contest the researcher's ideas. Member checking can also provide participants with an opportunity to reflect on their experiences. In doing so, peer debriefing enables researcher to provide questions and analyse the interpretations made, so aiding in the mitigation of research bias (Earnest, 2020). During the data analysis phase of this research, peer debriefing was employed by the researcher by engaging in discussions with two colleagues who were studying for their PhDs at the University of Nottingham. Through member checking with researchers and their peers, a thorough

examination of each stage of the data analysis process was undertaken, focussing on the themes and codes identified during the analytic process, with numerous instances of feedback being incorporated to verify that the data accurately reflected the thoughts and views of the participants while also minimising the potential impact of the researcher's own viewpoints.

Transferability refers to the degree to which the results of a research study may be transferred to other contexts and prove valuable to individuals in varied settings. This concept distinguishes itself from other components of research, as it is the readers who assess the relevance of the findings to their own particular circumstances. The goal of qualitative research is to yield theoretical insights about people and systems that can be applied and transferred beyond the original context by utilising the time spent carefully collecting, interpreting, and reporting data to produce meaningful findings that are useful to participants and other pertinent individuals. Transferability, also known as applicability, is an essential element of qualitative research since it requires both detailed description and detailed interpretation to be really effective. Qualitative research methodologies are sometimes described as providing a rich description. Denzin (1988) explicated the concept of thick description as a methodological approach that exceeds mere factual observations and apparent representations. The author proposes that the utilisation of thick description has the potential to shed light on social interactions and their associated significances. Thick descriptions facilitate multiple interpretations, and there are several justifications for their perceived importance. Firstly, a thick description is often regarded as a means of establishing credibility and trustworthiness; and secondly, the comprehensive nature of the descriptions enables the reader to ascertain the potential applicability of the study's findings to various other contexts. In light of the aim of the current study, which is to understand Saudi teachers' experiences and perceptions of the use of digital technologies for NV autistic students to manage their SC difficulties, across three schools in Saudi Arabia, the transferability of the findings would be limited to the local context and not to a broader study context. However, the rich data findings produced in this research may be presented to educational authorities for addressing the gaps in the use of digital technology for NV autistic students, to policymakers, and to future researchers. The richness of the data collected is derived from eleven semi-structured interviews with teachers, a total of six classroom observations, and methodological triangulation with reflective journals, observation sheets, and transcripts of interviews. The data collection methods employed in this study, namely conducting interviews and observations, have been thoroughly elucidated to ensure the dependability of the research.

Dependability pertains to the consistency and stability of data through time and in multiple study contexts (Earnest, 2020). The concept has resemblance to reliability in quantitative research, although it acknowledges the potential variability in the stability of settings, contingent upon the nature of the study being undertaken (Connelly, 2016). The procedures pertaining to dependability encompass the implementation of many measures, such as the meticulous upkeep of a record of activity consisting of logs or personal journals, as well as engaging in peer debriefings with a fellow colleague. Barlett and Vavrus (2017) discuss the role of documents such as personal journals and logs maintained during and throughout the course of research as a maintained chain of evidence that contributes to the dependability of the research. Therefore, in the context of the current research, the document logs are a comprehensive record and they were maintained by the researcher throughout a study. The decisions made about various components of the study, such as participant selection and observation choices, are also a source of data dependability.

This study employed confirmability as a metric to assess the transparency and trustworthiness of the findings. According to Connelly (2016), the concept of confirmability in qualitative research pertains to the mitigation of bias when presenting the findings of the study. Therefore, the neutrality of the findings and their consistency and replicability are crucial factors. This study utilises various data sources, including semi-structured interviews with audio recordings, interview transcripts, and observations documented through observation notes, reflective journals, and logs. The purpose of incorporating multiple sources of data is to minimise potential researcher bias. Furthermore, the inclusion of diverse participants, specifically teachers from three distinct schools located in two separate cities, who shared their unique experiences and perspectives, contributed to the richness of the gathered data. This approach allowed for a comprehensive examination of the data from multiple viewpoints, aligning with the principles of Lincoln and Guba (1985). Furthermore, the implementation of self-reflexivity serves as an additional means of enhancing transparency.

3.8. Ethical considerations

Ethical considerations are of utmost importance in qualitative research. Rumrill et al. (2020) note in their publication that in special education research, collection and analysis of empirical data is carried out on how special education learners respond to specific interventions and technologies, how their learning and performance are affected by grouping them in different ways, how their interactions with other students differ under varying contexts and conditions, how teachers' skills and characteristics impact students learning and progress, and similar perspectives to expand the knowledge base and to

further improve policy and practice. In accordance with these aspects, the impact of ethics is of paramount importance in the design, implementation, and dissemination of qualitative research, and when children are participants, respecting and protecting their ethical rights is even more imperative. Considering right and appropriate conduct is the underlying essence of ethics. Researchers in qualitative research have an ethical obligation that they owe to the study participants, e.g., special education students, teachers, parents, or any other relevant actors of the research. Hence, a responsible researcher's primary role is to keep in view the relevant standards and considerations to shape correct and appropriate research conduct that does not go against the ethical guidelines underlying all aspects of special education research (Brooks et al., 2014).

In line with the above-mentioned overview of behaving properly with research participants, the current study has taken into consideration all the relevant dimensions of ethics. To have a profound ethical approach, the British Education Research Association's (BERA) *Ethical Guidelines for Educational Research* (BERA, 2011) were adopted. According to BERA (2018), following ethical guidelines in research allows the balance of overall research intent, researchers' expectations, and participants' rights. The University of Nottingham and BERA's ethical codes of conduct were strictly followed throughout all the phases of the study. Moreover, ethical approval was granted by the School of Education Ethics Committee and is shown in Appendix 1A.

3.8.1. Informed consent

Informed consent is one of the most fundamental aspects to be considered in an ethical component of research; this originates from the notion that participants have the autonomy to decide whether or not to participate in the project. In this context, the researcher took informed consent from the proxies of the targeted students, i.e., their parents and teachers, before conducting the research. Farrow (2016) elaborates on this context of informed consent in that one potential way of predicting consent in school-based research is to determine the 'hierarchies of consent' – that is, obtaining permission at the different levels that are linked to the research. With regard to researching the school setting, the consent of wider educational authorities, the appropriate ministries, and permission from the school headteachers/leaders, teachers, and staff are crucial. In addition to this, parental permission is also important when the participants are dependent on their parents or caregivers, which is the case for special education students.

Informed consent to conduct a standard set of evaluations or observations is usually required from a school leader, class teacher, and parents of students participating in the research. The consent forms for parents and teachers are shown in Appendix 1B(a) and 1B(c), respectively. The consent form for the school leader is attached in Appendix 1C(a).

The current study thus sought consent at three different levels. In addition, permission to conduct the research was first obtained from the Saudi Ministry of Education (MoE). The Special Education Department under the MoE (2002) is responsible for providing special education services in different school districts. Approval was then gained from school leaders, teachers, and parents. This was formalised through an information sheet and consent form sent to the relevant parties to keep a record of their involvement. It is worth sharing additional details of the research (Farrow, 2016), so for that, the researcher had a meeting with the teachers in all the schools to obtain their approval and to address their queries before data collection, resulting in a significantly higher level of trust and confidence between us. Moreover, it also allowed them to assess the benefits and risks of participation for themselves and to discuss their concerns directly, rather than simply reading predetermined statements on the information sheet. The information sheet for parents is shown in Appendix 1B(b), for teachers in Appendix 1B(d) and for school leaders in Appendix 1C(b). The researcher fully ensured that the respondents (teachers) made an informed decision relating to their participation. Moreover, the participants were also given the option of withdrawing from the process at any time, as the purpose of informed consent is to communicate to the participants that taking part in or withdrawing from the study is a voluntary decision (BERA, 2018; Wallace and Sheldon, 2015)

3.8.2. Data confidentiality and anonymity of participants

Maintaining the respondents' trust and protecting the collected data fall under the domain of privacy, confidentiality, and anonymity in the ethical framework (Tourangeau, 2018). Babatunde et al. (2020) argue that in special education contexts, researchers should protect data and maintain the confidentiality and anonymity of the participants at the highest level.

Alibali and Nathan (2012) explain that each institute has its own framework for allowing the exploration of confidential matters through teachers, school procedures, and day-to-day classroom activities. Hence, to keep the research process smooth, the researcher obtained approval from the respective school leaders by communicating the purpose of the research and requesting the space and time needed for interviewing the teachers. As the current research focuses on input from teachers, it can be challenging and uncomfortable for them to disclose information that may put them in a difficult situation. Thus, being the subject of study, teachers were ensured of the confidentiality and privacy of the data and that the research would protect their input by ensuring their anonymity (by not disclosing their names and using pseudonyms instead; numerical and alphabetised codes were used to conceal the names of schools, students and teachers). Before this, the ethical committee gave its approval of the method for ensuring the protection of the data.

Ryen (2016) acknowledges the fact that safeguarding the information provided by participants is crucial to sustaining a trusting relationship between the participants and the researcher. Thus, teachers participating in the research were assured that all their data would be protected and no identifiers would be disclosed. Under the research ethics protocol, teachers were informed about the nature of data being collected, their rights as research participants, and also about confidentiality and anonymity protection.

3.8.3. Privacy concerns of vulnerable participants

Another important ethical dimension that was of relevance to the current research was considering pertinent disciplinary perspectives. The students targeted for observation fell into the category of vulnerable young people with special needs and limited capacities. In this context, the guidelines highlighted by BERA (2018) regarding the researcher's responsibilities towards these participants were followed. In the case of young people who are constrained by any vulnerable circumstance and who cannot fully provide their consent voluntarily, researchers must consider alternative ways of seeking approval on their behalf – i.e., through 'responsible others'. Keeping this in mind, the institutional heads (school leaders) were contacted for approval before conducting observations in this context. In addition to this, the ethical guidelines for vulnerable students from the University of Nottingham (UoN) along with the Child Safeguarding and Data Protection form were duly considered by the researcher, and all the requirements were met, as mentioned in 'Guidance on the Safeguarding of Children and Adults at Risk', to avoid any emotional distress or discomfort for the students during the observations (UoN, 2016).

3.8.4. Data protection

In addition to ensuring the anonymity and confidentiality of the participants, the researcher also ensured the protection of the data recorded in the interview sessions. To further protect the data and maintain privacy, participant names were not used, and other proof of identities were removed during data transcription. Pseudonyms were used instead of the original names. Any personal information was discarded and consent forms were secured in a personal locker.

3.9. Positionality and self-reflexivity

Qualitative research requires the role of the researcher to be determined in the identification, assessment, collection, and interpretation of data during the entire span of the research (Braun and Clarke, 2013). Moore (2012) reports that the researcher's positionality entails the set of beliefs, values, and moral aspects that cannot be ignored in

the research process; it is as fundamental as the physical presence of the researcher for completing the project. The researcher has both direct and indirect roles in the process of data collection and analysis, and it is crucial to consider the researcher's positionality, and whether they are an "outsider" or an "insider" (Holmes, 2020). An "insider" researcher is someone who performs research within a group to which they have personal affiliation and active involvement. Conversely, an "outsider" researcher investigates a group to which they do not possess any association. As the researcher, it is essential to consider positionality, which refers to the interaction between the researcher and the participants, as well as the researcher's position within the overall study context and its sample (Guba and Lincoln, 1994; Holmes, 2020). Within the framework of interpretive research, characterised by a subjective epistemological stance as opposed to an objective one, the researcher's potential influence on the study process emerges as a result of the interactions between the researcher and the participants.

Hence, it is imperative to highlight my academic proclivities and background that motivated me to pursue this topic. Being a native Saudi, I posit that in my capacity as a researcher I share several common characteristics with the participant Saudi teachers in terms of language, nationality, gender, primary education, understanding of national values, and the first-hand experience of being part of the general educational system professionally and academically. During my academic tenure, my work with autistic children has allowed me to develop a deeper insight and understanding of some of the unique obstacles that they face, such as social interaction difficulties, communication deficits, and other challenges. I completed my Master's qualification in the same area, a study that was devoted to assessing parents and teachers' attitudes towards the efficacy of digital technologies in supporting the social skills of autistic students. It is also worth mentioning that as a special education practitioner, focusing on autistic students, I have considerable experience with these students. Hence, I identify myself as an insider researcher.

Researchers have elucidated the distinct benefits of having an insider's perspective. Firstly, those with insider knowledge are more likely to possess an in-depth understanding of the topic at hand. Secondly, their presence is less likely to cause disruptions in social interactions. Lastly, insiders are more capable of eliciting accurate data from participants due to their ability to establish rapport, connect with them effectively, and develop acceptance. Therefore, these features aligned with my research context, as my positionality helped me to have smooth interactions with the participants in the research, and they facilitated me with rich narratives through their generous responses. I was also able to conduct observation sessions conveniently. Furthermore, a researcher's

comprehension of the cultural and social framework of the research context or setting can expedite the process of understanding the subject matter under investigation since they possess prior information pertaining to the topic at hand (Saidin, 2016). This feature of being an insider researcher further helped me to understand the participants' responses owing to my acquaintance with the cultural dimension. This enabled me to understand the various terms, narratives, and phrases, and also added to the confidence of the participants to be open in our discussions and share their perspectives. Relative to this, to avoid the propensity of being biased during data collection as an insider researcher, I remained objective by refraining from expressing personal ideas, comments, and thoughts regarding the topic under investigation. This insider position at the macro level also enabled me to overcome the drawbacks from my outsider status at the micro level, i.e., being in an individual classroom, by collaborating with teachers to address any possible challenges we may have faced while observing students. Therefore, my outsider status became a positive aspect, allowing me, with the teachers' cooperation, to elicit the required information beforehand and enabling observations to be made at suitable times during the learning sessions. The outsider status, however, also provided me with the ability to ask off-track questions such as those related to topics beyond educational policies (lack of training, teacher's knowledge, etc.) that often led to obtaining more information. Moreover, my outsider lens also made it easier to see things that are not perhaps evident or clear to the insider, such as a lack of technological accommodations or the availability of appropriate resource rooms. These factors allowed for a more objective portrayal of the reality and practices in each school pertinent to the study.

During the course of data analysis, self-reflexivity emerged as a significant area of contemplation (Holmes, 2020). Self-reflexivity is a method adopted by researchers to mitigate their impact on the study process (D'Arcangelis, 2018) through ongoing scrutiny of their own behaviours and intentions. According to Cohen et al. (2007), qualitative research relies heavily on the active involvement of researchers as the primary instruments in the study process. Self-reflexivity was incorporated into this study through the continuous supervision of the research progress. Regular meetings with my supervisors facilitated the practice of self-reflexivity by necessitating responses to inquiries regarding my actions, motivations, and justifications for the various stages of the research endeavour. This assignment proved to be particularly beneficial during the phases of data collection, analysis, and interpretation. Given the diverse contextual experiences of my supervisors, they were able to pose critical inquiries and offer constructive input pertaining to the study, so aiding in mitigating any biases. Furthermore, I actively participated in dialogues with my supervisor as well as fellow doctorate course participants and instructors. The consistent and regular gatherings and conversations held with fellow

colleagues facilitated my self-reflective process while I was engaged in data analysis and thesis writing. These discussions served as a catalyst for me to address and overcome any potential biases that may have influenced the study.

In this chapter, the research design and methodological approach selected for the study were outlined in detail. The philosophical stance was explained in the first section, along with the research paradigm. A justification for the use of the interpretivist paradigm, along with the decision to adopt a qualitative approach, was also provided; I explained that a multiple case study design was the most suitable approach to take, using a range of data collection methods including observations, interviews, and documentary analysis. I also provided a detailed overview of the thematic analysis employed in the study and how it was carried out in order to derive the study findings. The ethical considerations were also outlined in this chapter. The chapter concluded with an explanation of the importance of trustworthiness and self-reflection, and how I attained these in my study. The following chapter presents the findings obtained from the three case studies.

Chapter Four: Findings

4.0. Preamble of case studies

This chapter elucidates the findings obtained from three cases: i.e., three inclusive and mainstream schools in Saudi Arabia. The section elaborates on the insights gathered from different sources of data and the findings from the study participants, followed by a comparison of the similarities and differences in the use of digital technologies to support SC in NV autistic students in Saudi Arabia. The findings of the research are assessed in light of the research questions (see Table 7), and highlights of the common themes across each school against each research question and data collection method are presented.

Table 7 Structure of the findings

Chapter 4				
RQ #	*Research Question*	*Data collection Methods*	*Main Sections*	*Common Themes across three schools*
RQ1:	How do teachers use digital technologies to support SC in NV autistic students?	- *Semi-structured interviews (audiotapes, field notes)* - *Observations, notes (personal journaling)*	**Use of digital technologies to support SC in NV autistic students**	*1- Individualised educational curriculum* *2- Varying preference and use of technology* *3- Mixed approach enhanced SC responses and acquisition* *4- For unprompted responses and communicating (requesting) independently*

RQ2	In what ways do NV autistic students use digital technology for SC?	- *Semi-structured interviews (audiotapes, field notes)* - *Observations, notes (personal journaling)*	**Use of technology by NV autistic students**	*1.Tablet- and computer-based practices:* *a. Joint attention and engagement* *b. Social interaction in learning and collaborative activities*
RQ3	What are the factors contributing to the use of digital technology as a positive learning tool for NV autistic students?	- *Semi-structured interviews (audiotapes, field notes)* *Observations, notes (personal journaling)*	**Contributing factors of digital technologies in positive learning of NV autistic students**	*1. Learning and teaching processes* *a. Student affinity for learning interactive and engaging content* *2. Time, effort and experience*
RQ4	What are the barriers and challenges to using digital technologies to support SC in NV autistic students?	- *Semi-structured Interviews (audiotapes, field notes)* - *Observations, notes (personal journaling)* -	**Challenges and barriers to the effective use of technology with NV autistic students**	*Lack of performance follow-ups and parental cooperation Lack of teacher training and technical facilities*

Prior to the detailed narratives from each case, the common themes and findings analysed across all three school are discussed.

4.1. Educational curriculum for autistic students

The national curriculum was customised to address the learning and difficulty levels of autistic students across all three schools. In addition, the teachers were updated on the 'teaching guidelines' regarding the use of digital technologies, along with teaching strategies to accommodate the learning needs and difficulty levels of the autistic students.

The following narratives from teachers at each school highlight this aspect. Teacher 1 from School A commented:

"The individualised educational curriculum is applied as per the strengths and capabilities of each student in education, and we use additional assistance to make the best use of the curriculum to facilitate the lacking skills, i.e., sometimes sensory and visual integration, keeping the physical structure of the classroom suitable, daily schedules, and keeping visual cues and instructions quite engaging. Sometimes I get involved with them at an individual level and adjust specific teaching strategies to fit individuals' ability and their learning level."

Teacher 1 from School B added:

"The learning patterns of autistic students cannot be addressed in a regular learning and teaching environment. That is why we have to make sure that the learning content is not putting on them many social demands or a sensory overload, to avoid making them frightened and confused. We consider learners' strengths and interests and their learning styles when working on a task or activity. Therefore, this requires special accommodations in the curriculum to avoid having sensory problems and keep them motivated."

Teacher 3 from School C mentioned:

"The modification of the curriculum and content is based on the students' difficulties, and their further plan is determined accordingly. Sometimes teachers collaborate and delineate individual educational content as needed. For example, for a minimally verbal student, we combine different approaches to help address his joint attention and interaction difficulties, sometimes through prompting, contingent reinforcement, and time delay."

However, it was observed in School A that teachers were facing difficulties with addressing and reaching each student equally, due to their varying interests and difficulties, and a lack of assistance or additional staff in the classrooms. Relative to this, school B teachers made some accommodations to address the difficulties of autistic students working at the same pace as their peers; for example, the content of a session was broken down into small steps and tasks to fit the learning abilities of autistic students. Correspondingly, visual cues were added to classroom instructions to keep reminding them of important

tasks to follow. This implies that doing so fits the student's learning capacity, keeps them motivated, and increases learning opportunities. Similarly, in School C, different approaches and instructional strategies were adopted to address the SC challenges of autistic students. It was observed that various techniques and interventions (conventional as well as digital) were used across all three schools, such as teacher-aided interventions including PECS, manual signs, flashcards and Social Stories™. Nevertheless, it was quite challenging for teachers in School C to modify the activities to match the needs of different autistic students. Students who were completely NV and exhibited more challenges were, at times, addressed with a mix of teacher-aided instructions and technology. However, in school C the students were initially trained through flashcards, manual signs, and PECS.

4.1.1. Participant characteristics

The study group consisted of 11 teachers working in the three targeted schools. In terms of the demographic characteristics of these participant teachers, all were male, aged between 28 and 49 years old, and qualified bachelor's and master's teachers in special education.

The criteria to determine the participation eligibility of the teachers in the research were based on their teaching experience and experience working with autistic students. Moreover, the following inclusion criteria were considered:

- Had profound knowledge of and teaching experience with autistic students.
- Possessed sufficient know-how about current technologies such as tablet computers for autistic students.
- Had a prior history of teaching through conventional interventions for comparison purposes; and
- Had attended certain training programmes on the use of the latest technologies to overcome the obstacles faced by autistic children.

For the selection of NV autistic students to observe, they were selected on the basis of their verbal abilities (most of them were MV/NV) and their age, between 6 and 9 years old. All of the observed students were male.

This section presents the characteristics of the observed NV autistic students. They were observed for their interaction skills, their activity individually and within groups, and eye contact, facial expression and reciprocity in social interactions. Table 8 presents the demographic characteristics of the teachers and students (the students' record files were used to obtain this information) from each of the three schools.

Table 8 Characteristic and demographic details of participants and schools

School label and type	School A Mainstream (with resource rooms)			School B Mainstream (with resource rooms)			School C Mainstream (with spare space in mainstream)		
Technology used	Tablets (primarily); smartboards and projectors			Tablets, smartboards, and laptops (primarily) Computer talking programs, and projectors (secondary)			Tablets (some teachers bring their own), smartboards, and projectors		
Students' demographics	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Age (gender)	**6 yrs (M)**	**7yrs (M)**	**9yrs (M)**	**8Yrs-M**	**7yrs-M**	**9yrs-M**	**9yrs**	**8yrs**	**8yrs**
Verbal ability	>5 words/MV	>5 words/MV	NV	NV	NV	>5 words/MV	NV	>5 words/MV	>5 words/MV
SC Difficulties	Infrequent eye contact	Lack of interest in group activities	Resistance to participation	Screams and yells when tasks are assigned	Screams due to stress; receptively identifies common classroom objects	Resistance to participation	Lack of interest in group activities	Infrequent eye contact	Resistance to participation Lack of focus

School type	Primary students				Primary students				Primary students		
Teacher Demographics											
Teacher label	Teacher 1	Teacher 2	Teacher 3	Teacher 4	Teacher 1	Teacher 2	Teacher 3	Teacher 4	Teacher 1	Teacher 2	Teacher 3
Age	**37**	**49**	**40**	**43**	**30**	**40**	**49**	**47**	**28**	**38**	**45**
Experience with SNS	**6 yrs**	**10 yrs**	**5 yrs**	**7 yrs**	**4 yrs**	**7 yrs**	**11 yrs**	**13 yrs**	**5 yrs**	**7 yrs**	**8 yrs**
Qualification	Master's	Master's	Bachelor's	Bachelor's	Bachelor's	Master's	Master's	Master's	Bachelor's	Master's	Master's
Experience with technology	Basic know-how	Basic know-how	Basic know-how	Basic know-how	Basic know-how	Basic know-how	Basic know-how	Basic know-how	Basic know-how	Basic know-how	Basic know-how
The resource room is a specialised educational setting designed for children with specific learning disabilities (SLD). It is often located within the regular school environment and offers an individualised educational program (IEP) tailored to address the academic challenges faced by SLD students. The significance of the resource room becomes apparent when the general curriculum and general educators are unable to effectively address academic challenges faced by students with SLD. Therefore, these students are placed in a designated resource room based on a specialised timetable, where they are allocated between 21% and 60% of their daily school hours.											

Case Study 1: School A (Riyadh)

4.2. Description

School A – this mainstream inclusive school was located in a central area of Riyadh facilitating both Saudi and international students. The school enrols students with or without learning and developmental difficulties. A total of 40 special educational needs students were enrolled there at the time the study was conducted, as per records shared by the school leaders (11 were autistic students, while the remaining 29 had other intellectual and multiple disabilities). School A also had both mainstream and resource rooms for autistic students, where they were taken for special lessons when needed. The observation in the natural setting of the classroom allowed the researcher to record multiple perspectives of the participant students, including the session objectives – i.e., the type of instructional strategies (individualised or group) that the teachers incorporated into their practice to engage NV autistic children through the use of tablets to enable SC (joint attention, social engagement, and communication skills).

RQ1. ***How do teachers use digital technologies to support SC in NV autistic students?***

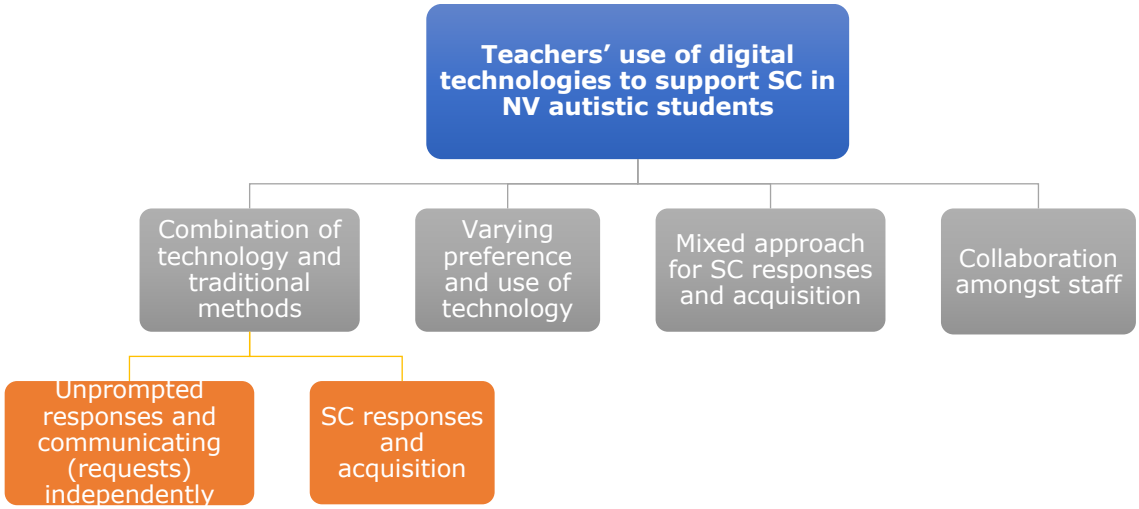


Figure 7 Themes obtained under RQ1 School A

4.2.1. Combination of technology and traditional methods

Teachers in School A were oriented towards using a combination of digital technologies and traditional teaching. They believed that this would provide a balanced approach, avoid

over-reliance on technology, and keep students directed through their verbal and guided support. The use of digital technologies was acknowledged as an assistive means of practising SC in NV autistic children. Moreover, teachers were also of the view that a mere focus on devices diverts the students' attention from communication goals towards entertainment only. One of the teachers responded:

"The use of digital technologies along with traditional methods is quite helpful and more user friendly because it adds a new way for the students to communicate with each other. Using interactive images and applications engages the student more easily. But, I believe in naturalistic teaching methods too because relying only on devices has many consequences too, like too much use of the device and getting diverted by other applications and games."

Another view mentioned by a teacher reflected the fact that technology is not always a solution to the SC difficulties of autistic students. There are certain challenges that limit technology to a mediatory tool and not an all-in-one solution. Technology-based programs are not always designed in a way that suits the complex learning needs of these students, as Teacher 4 mentioned:

"For technology-based learning of these students, the content of the program should be developmentally appropriate for the learner to keep them attentive. We have to select an application that is relevant to our course content and curriculum to improve their developmental milestones. But we have very limited options. So, we use general features of the device sometimes to engage them. The application and programs' interfaces are not always student friendly; they have complex settings that need mature navigation and cannot be controlled by the student alone."

Hence, this denotes that technology embedded in a classroom setting with regular teaching strategies influences practice for SC of NV autistic students

4.2.2. Unprompted responses and independent communication (requests)

The use of digital technologies was also found to be effective in increasing the frequency of unprompted responses. It was observed that after a certain period of time, the need to prompt certain actions faded when teachers helped students to use the devices for the practiced skill. Despite being more oriented towards conventional teaching, one teacher commented that if the prevalence of technological practices is maintained, digital technologies can further enable the desired behaviour:

"After helping them [NV students] use the particular devices for quite some time, we reduce the support and amount of help being given to them in making a request after a

certain period of observation, to see if the student will operate it on their own or not. If not, a slight physical/verbal prompt is given to initiate him. With persistent trials, we moderate the amount of prompting to enhance their independence."

The findings also denoted that digital technologies directed the NV students to learn and then respond independently in ways that were not easy to accomplish through traditional means such as PECS, owing to the preference, affinity and engagement of students with technology-mediated learning and practice. Digital interfaces not only help them to iterate their attention and interest but also enhance their spontaneity to use the devices independently to make a request and communicate their needs. The longer learning sessions on digital interventions (due to their interest and engagement) were observed to facilitate the frequency of communication among the student participants. With appropriate practice, guidance, and time, it was observed that the students' reliance on external prompts was reduced, and the student operated and navigated through the different screens of the application on their own to find corresponding prompts or reinforcers and communicate their requests.

4.2.3. Mixed approach for SC responses and acquisition

The careful selection of both digital devices and other teaching materials and activities was reported to enable SC responses for NV autistic students. The teachers believed that a mixed approach of digital technology, traditional approaches, and teaching strategies complemented each other.

"We focus on directing the non-verbal students towards responsiveness towards their peers and classmates rather than prompting them towards communication initiation. So, through the right mix of both technological tools and other strategies, we structure the learning sessions to motivate their participation as well as interaction with other students."

Joint attention and social engagement are prerequisites to SC in autistic students. During the observation session, the researcher observed SC responses through use of digital technology, using prompts in the initial trials and then diminishing the prompts as they showed independent practice. The student participants were observed to join in with the cooperative play session on the tablets, and during this time, their joint attention and engagement were assessed while they made requests using the correct image on the screen. To further assess the SC response, the researcher pressed the symbols on the tablet that were of interest to the student; for example, the symbol for 'Let's play' produced a jiggle and ringing sound after exclaiming 'Let's play!', and the student pointed at the symbol and then moved his gaze towards researcher and smiled, that indicated his engagement and joint attention response during this activity.

4.2.4. Varying preferences and use of technology

Different learning sessions used different digital technologies, but mainly the participants used tablets provided by the school and sometimes brought in by the students themselves. The tablets were protected by cases and had a few Arabic applications and learning games installed that were used to practise communication. To avoid damage to the device, a plastic seal was clipped onto the home button. The classrooms were facilitated with projectors, smartboards, and personal computers. Teachers and some students had their own tablets. Projectors were mainly used to display videos or movies. When a more personalised skill was to be learned, tablets were used, and for interactive group sessions, projectors and smartboards served the purpose. Teachers and students were both observed to prefer using tablets over other devices. In the interviews, the teachers commented that they preferred the accessibility offered by a touchscreen compared to desktop computers, as using the mouse to position and manoeuvre the pointer on a desktop screen was difficult for these students due to their level of motor coordination. Touchscreens therefore provided an advantage for autistic students with motor difficulties:

"We prefer to use touchscreen devices more often as students use them at home as well. You see, the desktop computer requires motor skills, and these students have a few difficulties with using that. But when we practise tracing on a tablet, believe me, they perform well."

However, some of the teachers also preferred using a projector as for them it enhanced facilitated joint learning by showing movies and interactive sessions, more so than a tablet, which was not safe for some students. Likewise, some teachers preferred the technological tools that offered ease of customisation. They believed that digital technologies may be visually appealing for autistic students, but that it is not always easy to use them in a given situation. Teacher 2 explained this:

"I don't prefer handheld tablets due to their unexpected behaviour and the students' capacities to operate the device alone. I prefer learning through a projector screen displaying educational videos."

The frequency of technological sessions was based on the needs and requirements of the learning session, as Teacher 4 stated:

"Every autistic student is at a different level. A device/application may be more suitable for one and less for another. I may sometimes use it in between a session to keep them going."

To keep the students engaged in the initial trials with the devices required more effort, and their preferred snacks/toys were brought along as reinforcers when they had difficulty performing an activity. The initial sessions had four to five learning practices and varied according to the learning stages of the children (who varied from MV to entirely NV). The structured or either free flow practices in technology-based sessions offered opportunities for reflective spaces and practices that would regulate their SC challenges specifically accomplishing their attention, engagement and interest (leading to responsiveness and regulating their social interaction). An example is given below.

Teacher: *'What do you want?*

Student: No spontaneous response.

Teacher: Gives verbal prompt.

Student: No response.

Teacher: Gives physical prompt (hand over hand) on the device to press the request for food.

Student: Responds after physical assistance

The observation session recorded how the child responded and interacted with the device, their gestures, joint engagement, and consistency until the teacher remained engaged with him.

RQ2. In what ways do NV autistic students use digital technology for SC?

Embedding technological devices into the curriculum and learning activities required the NV autistic students to use these tools for engagement, enabling them to manage their joint attention through social reciprocity between various exchange moments in a collaborative session and through social interaction. However, the frequency and intention of use of a digital technology depended on their behaviour in the given setting; a motivator or reinforcer may have been required to direct their use. Other factors were the availability of devices and the teacher's expertise in using them. The following themes elaborate this perspective.

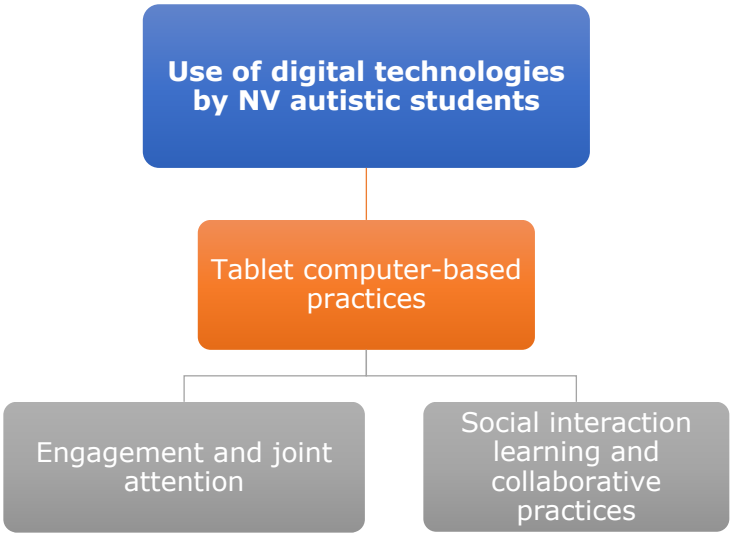


Figure 8 Themes obtained under RQ2 School A

4.3. Tablet-based practices for engagement, joint attention and social interaction

Tablet-based applications have been found to motivate two important aspects of joint attention, namely attention to peers and social cues. The interactive interface that a digital device offers engages the attention of autistic students more than the regular materials they are offered in a normal learning session.

4.3.1. Joint attention and engagement

For the more complex NV students, teachers used multiple strategies with digital technologies to direct the desired SC skills. For example, Student C was NV and it was quite a challenge for teachers to obtain his attention and engagement; he exhibited social isolation throughout the lunch and play periods, initially to manage such social isolation, cooperative integration groups were organised to engage and socially interact with the regular students. The teachers added that in such situations they also used peer-mediated sessions and interactive games to address the communicative responses of NV autistic children. Their responsiveness was described by one of the teachers:

"We usually arrange digital puzzle games session that really motivate the joint attention of these autistic students. It further encourages them to interact with each other. We achieve this with a group of two students and one teacher each, which is seen to achieve moving of the eye gaze to join pieces, and making eye contact with the other partner due to joint actions and turn-taking on the game screen."

On the whole, it suggests that collaborative games are a means of enabling the joint attention and motor skills of these autistic students. Another interesting dimension that contributed to initiating joint attention was student's pointing to a random error notification that appeared during the collaborative game or activity session. followed by giggles or smiles with each other, which also reflected their shared engagement and attention.

4.3.2. Social interaction in learning and collaborative practices

The findings demonstrated that teachers also used digital devices as a medium to increase collaboration and interaction in NV autistic students, demonstrating the necessity of the integration of technology, leading to positive impacts on pedagogical practices. One of the teachers commented:

"The programs and games on devices allow us to make these students learn to sequentially organise their interactions through multiple modes to enable turn-taking in digital games, which help them in social interaction."

This also relates to the observations made on collaborative technology-based activities, e.g., games being played in an integrative group on a tablet, where games help them with their social skills. Turn-taking and waiting for their turn enable them to do things together, and observing each other's actions helps them to overcome social aversion or isolation.

The interactive role of technology in social interaction were also observed in shared reading tasks, including storytelling and other reading activities on the tablets by teachers. The teacher-led reading practices on tablet computers accomplished engagement of these students in an integrative group .One teacher gave their opinion of interactive processes on devices in the following comment:

"The engaging visuals of videos stimulates them to interact, e.g., we at times show them their siblings or relatives in those videos and when they recognise them they are excited to interact with them somehow."

Teacher 2 mentioned that it is a challenge to get an autistic student to socially interact, and a reinforcer will help them to motivate the autistic student to get along with other students.

"Social interactions can be supported through interactive means such as the interactive projector and educational games where the child participates in the education process with his friends. But it is not easy to get them close to other students; you have to try. For that, we have to reinforce their social interaction; we encourage the child to win and get

rewarded. We reinforce their social behaviour to interact with others through certain motivators. The process of engaging this way increases the joy of the child as well."

The above perspectives provide insight into how using digital technologies imparts positive changes in the SC skills of NV autistic students. It is also deduced that the provision of a digital tool alone may not automatically support SC, but requires a proper instructional format, customised schedules as per the students' needs, and appropriate teaching approaches built around the learning characteristics of NV autistic students. Although some students may exhibit challenging behaviour in the initial learning practice, better participation is achieved with effective teaching strategies.

RQ3. What are the factors contributing to the use of digital technologies as a positive learning tool for NV autistic students?

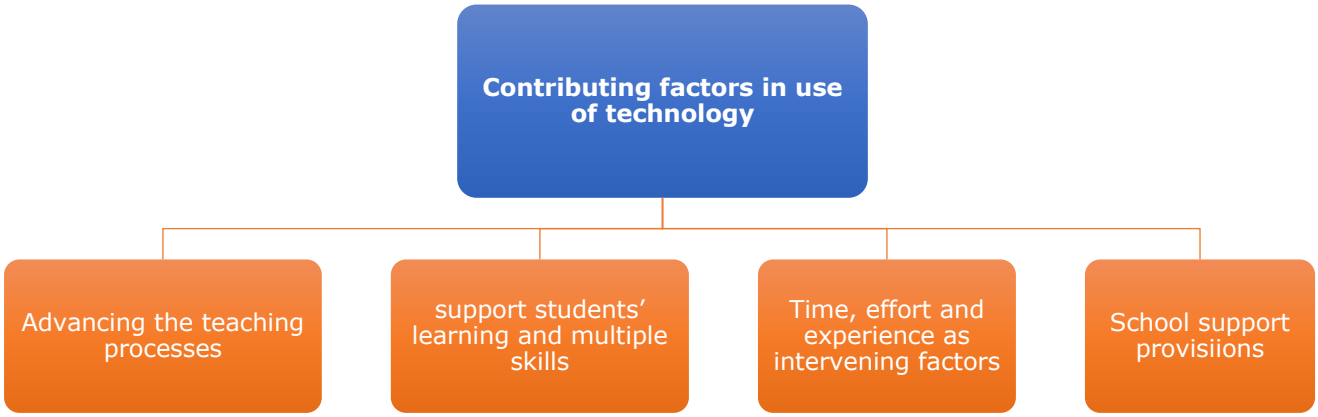


Figure 9 Themes obtained under RQ3 School A

4.4. Contribution of digital devices to support learning and teaching processes

This section explores two dimensions of using digital technologies, i.e. support in autistic students' learning and their contribution to the teaching process. It starts by discussing how different methods were enacted to enable the SC of NV autistic students.

4.4.1 Advancing the teaching processes

The use of digital technology produces observable changes in teaching and instructional techniques in terms of time, effort, and results. These digital alternatives were effective in fostering the conditions for learning through collaboration that further supported NV

students' SC , and they have also aided teachers in determining instructional strategies for these students. Teacher 3 shared his opinion that technological devices are more advanced for learning and teaching processes, as conventional methods alone may not accomplish progress even with multiple and longer trial sessions:

"It is time consuming to design learning content through traditional means, it takes more effort, and needs extra assistance from teachers and staff to engage the students. If we incorporate devices into the scheduling of classes and courses, I can engage and interact with the content of the learning sessions more efficiently."

The design and structuring of content and materials to address the multiple difficulties of NV students are made easy by digital devices. Teachers are of the view that multimethod traditional interventions are sometimes time consuming to design, and they require more effort from the teacher relative to technological devices that direct teachers to design-focused instructional content for facilitating learning. Teacher 2 commented that during his time of teaching autistic students over the last 10 years, he has experienced a faster learning cycle of students:

"It [digital devices] helps teachers to design and organise knowledge smartly and in innovative ways that are compatible with the needs of an autistic student, and then enables teachers to implement that in a procedural way in contrast to conventional methods."

Due to increased scientific support for technological and digital devices, i.e., portability, acceptance, and convenience, teachers have found that it is useful to integrate technologies into the strategies they implement with their students, as they offer convenience, mobility, and accessibility, facilitate assessment, and encourage independence in students.

"Every student is different on the spectrum. You see that NV students are not the same, and some pose more challenges than others and are least verbal or may not respond to maximum prompts or reinforcers. Most autistic students are attracted to devices, which helps us to work with the most challenging students. Undoubtedly, technology has made it easier for teachers to keep track of the time and effort they expend for learners."

Along with all the positive aspects, there are certain implications that teachers face when using and integrating these devices. The cognitive differences, sensory processing delays, and expression and motor skills challenges exhibited by autistic students can at times limit the actual benefit and convenience of technology. Therefore, teachers had to use the right mix of conventional interventions and technology. One of the teachers mentioned:

"Technological devices are the go-ahead for many, but they also come with so many requirements and challenges. You have to be outstanding when using them. It needs a comprehensive evaluation of the child's academic and movement, and other studies must be made."

However, teachers also commented that when the opportunity to learn through digital resources is availed, the technical problems associated with the device may need extra time and effort from teachers. In addition, the absence of technical assistance to address such problems is another obstacle. One of the teachers stated that:

"It is not always easy going to use technology. Once you encounter any troubleshooting error or any faulty part in the device, you will have to waste a lot of time. There is less support here for such problems. Then we have to look for other options."

4.4.2. Students' learning and multiple skills using digital technologies

The affinity of autistic students (MV/NV) with the use of digital technologies has been found to influence multiple dimensions of their developmental profiles. The versatility offered by the interactive interfaces of these devices and different technological features leads to the increased engagement of autistic students, and this is one of the potential challenges faced by teachers. One of the teachers commented:

"It is potentially challenging to win their attention! Collaborative technologies have made it easier for us to retain their attention, make them sit for the required time during an interactive session, and socially engage them by customising content as per their interest and motivation."

In addition to support to multiple learning difficulties, the integration of technology into learning relates to a quality improvement of teaching methods. A teacher at School A was optimistic about the further integration of technology:

"*The time taken for students to exhibit required response is reduced, when compared with pre- and post-practice with devices of technological sessions.*

One of the teachers disclosed the following information:

"If I compare the progress made by students with primitive techniques with the performance they show with technology-based lessons, I can see a difference. It has reduced the time period provided that we don't encounter any issue with the device itself."

4.4.3. Time, effort, and experience as intervening factors in SC skills

In addition to other influential factors such as effective teaching strategies and the skills of teachers, teachers' experience, effort, and time are also important factors for the

effective application of technology and supporting NV autistic students' SC. Teacher 2 commented:

"Sometimes, the use of these applications takes a long time because additional effort and time are required for the teacher to adjust the features as per the needs of each student. Sometimes some features of the application are not suitable for all autistic students. So, we have to be cautious then."

Another teacher added:

"The time and effort spent on each student are different. It's the learning level and skills complexities of students that determine the time and effort put in by a teacher."

Another teacher contradicts this view that learning and experiencing the benefits of technology needs time, as it is an integral part of daily life, so for them, using it with students to help them achieve communication and social skills milestones only requires an effort to identify students' learning propensity:

"At the present time, I do not think that it needs more time. The reason is that we use technology in our public life quite a lot. We are used to its presence and ease of control. As for the teaching process, we definitely need effort and experience as we are to practise the teaching process with autistic children."

The effort and time associated with the use of any technological application are also dependent on the difficulties and learning needs of autistic students. In order to meet the varying communication and social needs of NV autistic students, the applications need to be highly customisable and offer the option of adjusting the features for each student. Teacher 3 commented:

"Even though these apps are quite effective in engaging and improving their SC, but sometimes it can be challenging. These autistic-assistive apps are not highly customisable, which limits their usefulness, and we don't have much variety, and very few of them are available in an Arabic version."

4.4.4. School support provisions

The role of school authorities is important in the provision of digital technologies and then keeping up with the status of a technologically mediated learning environment. Teachers were of the view that school authorities should recognise the importance of follow-ups and the resource needs of teachers and students. They also emphasised the need for upgrades from time to time, as the needs of autistic students' progress over time. Hence, one teacher urged:

"The technological support is up to date, but I feel it needs continuous development and updating. Being educators, we rely primarily on the resources provided by the administration."

The above response implies that school authorities should recognise the need to provide the necessary support and assistance. A teacher commented on the increased emphasis on the provision of technology as a solution for special needs students by the Ministry of Education (MoE) in the Kingdom of Saudi Arabia, but there was a lack of support from school administration:

"The due support and assistance with special education programmes is emphasised by the Ministry of Education in the Kingdom of Saudi Arabia but school administration is slow to make the necessary provisions."

According to these responses, the school administrators need to address the prevailing needs of teachers to use technology efficiently.

RQ4. What are the barriers and challenges to using digital technologies as a tool to support SC in NV autistic students?

4.5. Barriers and challenges to the use of digital technologies

While digital technologies provide many positive benefits, an assessment was made of the challenges limiting the optimal use of digital devices. The most prevalent barrier was technical issues and the lack of timely support to address them, followed by teachers' training provisions.

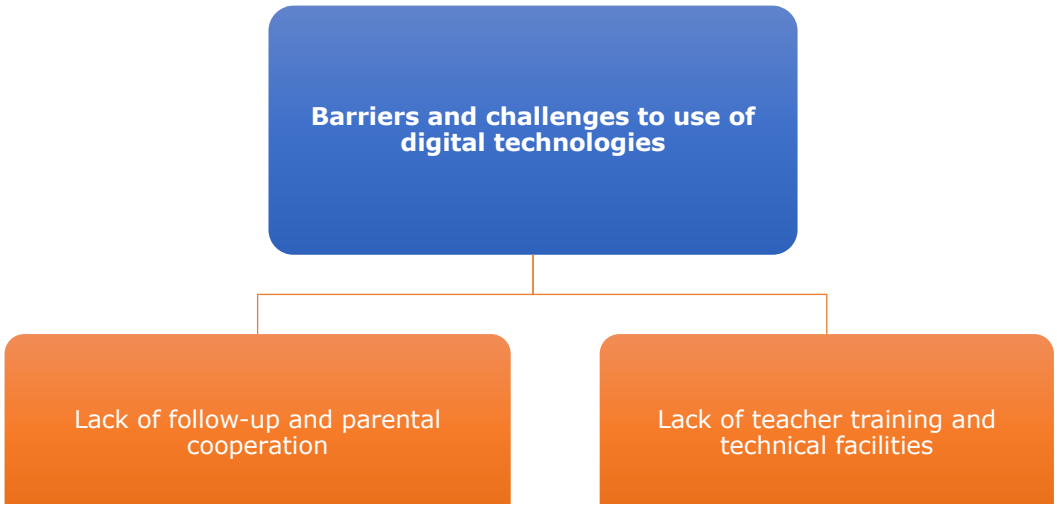


Figure 10 Themes obtained under RQ4 School A

4.5.1. Lack of performance follow-ups and parental cooperation

Another perspective covered in the support section was the maintenance of student follow-ups after a skill had been accomplished. School A carried out a teacher and student evaluation of performance and learning. This was also shared by Teacher 1:

"The performances of the student and the teacher are evaluated through regular follow-up to measure when the student has shown some improvement and to track any gaps on behalf of teacher's effort or any other disruption."

However, according to teacher 2, measures to maintain follow-ups were not regularly practised. The facilities are adequate, but the procedures and schedules to record the follow-ups were missing, as per the teachers' comments and also from the observation session.

"I think that working in the field of teaching autistic students, our school needs to comply more with follow-up procedures to evaluate the actual contribution of technology and its educational outcomes for autistic students."

A more serious concern was the lack of adherence of parents – and, at times, school authorities – with the regular use of technology and digital devices. Parents, at times, may lack the finances required to keep up with the technological sessions of autistic students as they are financially bound to provide students with the required gadgets and tools. One of the teachers said:

"The lack of cooperation from some parents … is one of the main obstacles that emerges from time to time if they don't see progress due to some irrelevant reason, but not technology."

4.5.2. Lack of teacher training and technical facilities

There was a lack of technical resources, i.e., availability of the required devices in each classroom for each individual student. At times, a learning session may be suspended due to technical faults in devices, and the lack of the required features in Arabic to suit their needs. A small number of devices distracts the attention of autistic students off the learning track, as informed by the teachers:

"Technical issues stop the regular flow of lessons. I face this issue most of the time – i.e., breakdown of devices or running out of battery. Schools should provide us with some back-up strategy."

Teacher 3 explained:

"Technology doesn't come with ease of use all the time for autistic students. We don't have many applications in Arabic and not all applications offer the option of customisation".

The need for well-designed training was emphasised by teachers on a variety of topics, ranging from general tablet operations to the use of tablets and apps in academic lessons, and technical training to overcome issues they faced while using them with NV autistic students. All of the respondents indicated the need to update the training facilities. Teacher 1 commented:

"The digital domain is growing globally. I believe that teachers need to be informed early on about new technology-based learning strategies to better use tablets and other tools to help address the difficulties of autistic students."

Moreover, several times during the observation, it was noted that when some devices were malfunctioning, the teacher had to call for technical assistance to fix them, which led to time being wasted. Technical errors and malfunctioning devices disrupt the flow of a learning session, and this may hinder the success of overall learning. Similarly, teachers were motivated to learn technical and technological information on their own to keep themselves updated on new applications that may help them with their NV autistic students' learning.

"There must be frequent training opportunities for teachers for efficient performance. Training is a substantial factor in addressing teachers' expertise. I keep myself updated with new applications available online for autistic students, but most of the time, they have to be purchased and not in Arabic."

Summary of findings:

1. Teachers integrate traditional instructional methods with digital technologies to support SC in NV autistic students.
2. Designing the right mix of digital programs for each NV autistic student, i.e., individualised digital curriculum and programme.
3. There is no single solution to manage SC challenges in NV students, as the varying needs and learning profiles of each student require different digital solutions.
4. Successful execution of digital devices requires persistence of time and effort, and teacher experience.
5. Support from the school administration develops positive attitudes and perceptions among teachers towards the use of technology to support SC in NV students.

6. Important support factors such as training, resources, and following up of progress/performance measures should be addressed on a regular basis by the school administration.

The next section elaborates on the findings obtained from school B in Riyadh.

Case Study 2: School B (Riyadh)

4.6. Description

The research site, School B, is a primary school within the Riyadh District, KSA. The school is a mainstream inclusive school for both general and special education students. The school had 12 classrooms with 25 students each, for children in kindergarten to Grade 8, and the ages of the students ranged from 3 to 15 years. The school has a predominantly Arabic population, with 90% of students being Saudi nationals and the remaining 10% of other ethnicities. The classrooms were safe in design and set-up, equipped with basic learning requirements to teach students with special needs (visual materials, posters, reminders, charts). The integration of special-needs students allows an interactive social environment where they are helped to interact with mainstream students (when grouped as peers) to address the challenges of social inclusiveness. They receive the lessons modified for them in collaboration with general education students. The school is equipped with resource rooms that contain different categories of facilities to address learning needs (including tablets, laptops, smartboards, projectors, etc.). The following section details the demographic details of participant teachers.

4.6.1. Details of digital devices

Teachers mainly used tablets, and projectors in the classroom. In addition to these, teachers also reported using computer talking programs and sometimes video recordings according to the requirements of a lesson or the learning needs of the students. The observation session recorded that tablets were the main devices being used most of the time. The interview session revealed that the proclivity of teachers towards tablets was mostly due to their ease of use, to customise applications according to students' needs. Teachers also discovered that tablets were convenient because so many students own them at home and use them for various purposes, with three different categories of applications installed: academic apps (used for addressing the specific communication challenges of the students, learning numbers and names of things); and augmentative and alternative communication (AAC) apps. Teachers' and students' sessions mainly used tablet (AAC)-based practice. The application used offered the choice of Arabic and English, and had three screen pages with relevant pictures and corresponding words for each item in different categories, with five or six items within each category, e.g., food items, animals, and clothing. The device produced speech output when the student tapped it with a finger; for example, selecting the picture of a dog produced the output "Dog". To obtain the acquired response, tangible stimuli were used as reinforcement by the teacher,

depending on the students' interests, in a typical learning session using a digital tool, e.g., allowing them to play their favourite game on the tablet.

It was observed that during the trial sessions the students exhibited repetitive responses on tablets, such as touching the picture repeatedly. To avoid that, the teacher started each new trial by giving physical prompts, for instance, keeping the student's hands on the table. Also, verbal reinforcement was given when the right response was provided by the student and when repetitive touching was avoided (e.g., 'Excellent!' 'Good job!').

The following section reflects the teachers' preference for traditional vs. technological devices used for supporting SC in NV autistic students.

RQ1: ***How do teachers use digital technologies to support the SC in NV autistic students?***

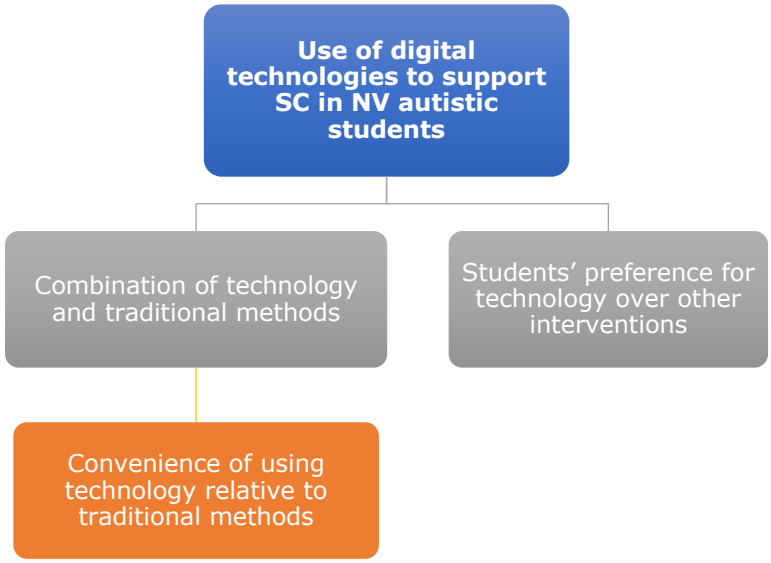


Figure 11 Themes obtained under RQ1 School B

4.7. Combination of traditional methods and digital technologies

The findings from the study demonstrate that the teachers were inclined to use technology-assisted learning with autistic students in combination with traditional methods. Technology served as a reinforcer to direct students' attention and engagement with the teacher's instructions. Teachers believed that it was not easy to improve the complex SC difficulties of autistic students with traditional measures and methods alone.

The observed students were found to be more engaged with the interactive medium and enjoyed repeated practice on the device.

4.7.1.1. Convenience of using technology relative to traditional methods

The research findings disclosed that interactive interfaces helped NV autistic students to request and label objects in order to communicate their needs. This was challenging with teacher-led instructions executed through PECS or flashcards. Teacher 2 mentioned:

"The ease of using portable devices is far more convenient than teacher-led instruction. The change in the learners' attention to the task and the occurrence of undesired behaviours during the technology-based sessions. The students' ability to recognise the alphabet, and to label and respond through a correct command on the application reveals that the medium used for instruction supports the overall learning process through increased engagement and interaction between peers, teachers, and autistic students."

The challenges faced by autistic students in relation to expressing their needs are difficult to address even at a basic level with people around them. Traditional means of enabling SC are more mainstream and less engaging. The findings suggest that teachers were motivated by the convenience that technology offers in directing students and managing their SC difficulties. Teacher 1 said:

"Technology-based teaching is more convenient and effective, and it is quite influential in the education of autistic students. It has helped me quite a lot with practicing communication skills and to improve their communication issues through regular practice, e.g., one or more practice sessions increases their expressive gestures (pointing at or pressing the right response), and assist responsiveness to questions without prompts with time."

Another view that was posited in this domain relates to the balanced use of technology and traditional interventions. Teacher 1 was also of the view that:

"Over-reliance on technology is not favourable, but using balanced technology for the autistic student is complementary to traditional strategies. Designing a curriculum that offers a balanced use of both the approaches can improve learning outcomes."

4.7.1.2. Students' preference for technology

The teachers' inclination to use technology over traditional interventions was also guided by the students' preferences. Different classroom activities demonstrated the students' strong attraction and preference for tablets. Teachers reported that the ease of using

tablet-based programs overcomes the agitation that students face with traditional picture exchange protocols and manual sign language. Teacher 3 reported:

"Comparative to traditional interventions and methods, devices are a much easier interface for non-verbal autistic students to communicate with."

Some of the NV autistic students are further challenged by their motor skills, so the ease of using devices develops their interest in interactive tools. Teacher 4 commented:

"Many of my non-verbal students demonstrated limited use of PECS due to limited motor skills. With the use of PECS, flashcards, and other visuals, there was no significant improvement in SC, i.e., for requesting, rejecting, and commenting; But, after having practice of sessions on the tablet, they were seen to be engaged in higher than usual communicative responses and behaviour, e.g., pointing to an object on the screen, responding to queries with nodding and shaking their head."

An observational recap in this context is provided below.

Observation Summary

During classroom observations, where PECS and flashcard activities were used for NV autistic students, the teacher demonstrated a comparison of two approaches: PECS-based and tablet-based, as requested by the students. The students were less engaged and attentive during the PECS-based session than in the tablet session. During tablet-assisted instruction, less frequent prompts were required after one or two learning practice, and responses were accomplished with fewer delays.

The findings from the interviews and observations relate to the fact that interactive and technological media are more motivating and engaging for autistic students because these children possess strong visual processing skills, revealed through their deep interest in visual media. Also, significantly less effort is required when using technology-based practice and it demands less complex motor skills than conventional methods such as manual signs and language, as the learning process entails various steps of interaction using multiple symbols and signs and hence it relies on having complex motor skills. Digital applications and programs can be used persistently and repetitively. However, as well as having a positive orientation towards the use of technology in combination with other techniques, teachers had concerns over student's overdependence on and addiction to digital technologies.

RQ2: In what ways do NV autistic students use digital technology for SC?

The second section relates to teachers' understanding and experiences of NV autistic students' use of digital technology for SC in School 2. The major theme is students' use of digital technologies for providing multiple responses and improving their learning attributes. Figure 12 below outlines the themes related to the factors affecting teachers' understanding.

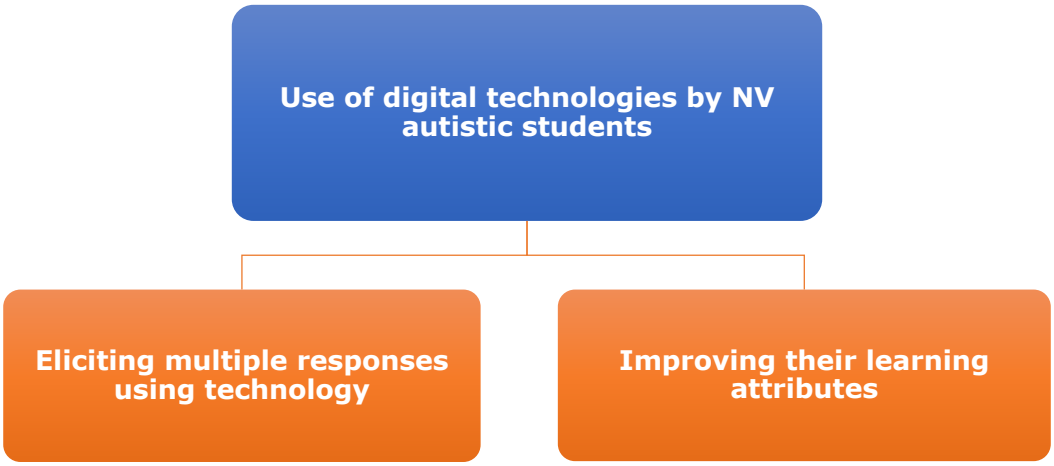


Figure 12 Themes obtained under RQ2 School B

The findings identified that teachers attempted to address the SC challenges of NV autistic students and emotional challenges through the use of technology. Devices engage autistic students, and the multiple advantages of using these devices have been found to address their challenges of speech and communication attempts to enable them to engage socially by initiating activity to communicate.

4.8. Eliciting multiple responses using technology

Relative to traditional approaches, technology-assisted instruction was found to generate different responses. It was observed that participants exhibited different responses using digital devices (tablets), i.e., request, emotion, and labelling responses. One example was when students were making requests on an application and request making was learned by pressing the picture/request under the desired activity, e.g., "I want a chocolate," as a simple request response.

Another response observed during the session was an emotional response, i.e., communicating how a student is feeling. For instance, while playing a collaborative game on a tablet, Student B and Student C were paired in a group of two, and Student B pointed to the happy face icon while using the tablet: "I am happy". Her partner, Student C,

subsequently imitated her and pressed "I am happy" in response. This implied that after a certain session of guidance, support, and prompts from teachers, their imitation is enabled. This also presents an opportunity for them to develop their understanding of feelings through recognition of emotion from a status visual on the screen, which leads to assisting them with ToM.

4.8.1.1. Enabling learning attributes through device-mediated motivation

The findings illustrated that technology-based learning kept NV autistic students motivated and engaged. The most critical challenge experienced by autistic students in learning is engagement. When autistic students are engaged, their ability for joint attention and social orientation is enabled. Teacher 4 disclosed that:

"The digital devices offer an interactive and engaging platform that enables control of their unexpected behaviour; they are more likely to engage in activity participation and social and task-related communications."

The interest of autistic students in visual media and devices relates to the fact that they have relatively strong visual processing skills. Teachers pointed to the fact that technology-based learning is more attractive to them due to its ease of use, along with fewer transitions, and the fact that it offers a student-oriented pace. The use of a one-on-one structured, predictable, and controlled environment through the use of technological tools facilitates joint attention, social orientation and interaction that further enhance the students' overall social profile. Teacher 3 mentioned that:

"I believe that using technology is more facilitating and interesting for students. During my use of technological devices with them, the complexities of interaction that we both normally face in any traditional intervention are reduced."

The next section addresses how technological devices at School B play a role in the overall learning of NV students and the teaching processes of teachers.

RQ3: What are the factors contributing to the use of digital technology as a positive learning tool for NV autistic students?

The exploration of teachers' understanding and experiences of the factors contributing to the use of digital technology as a positive learning tool for NV autistic students in school B revealed that positive social interaction skills, peer-to-peer socialisation, time, effort, and experiences using digital technologies were influential factors. The two subthemes of ease of designing the content and curriculum; and collaboration, engagement, and joint attention also emerged. Figure 13 below outlines the themes highlighting these factors.

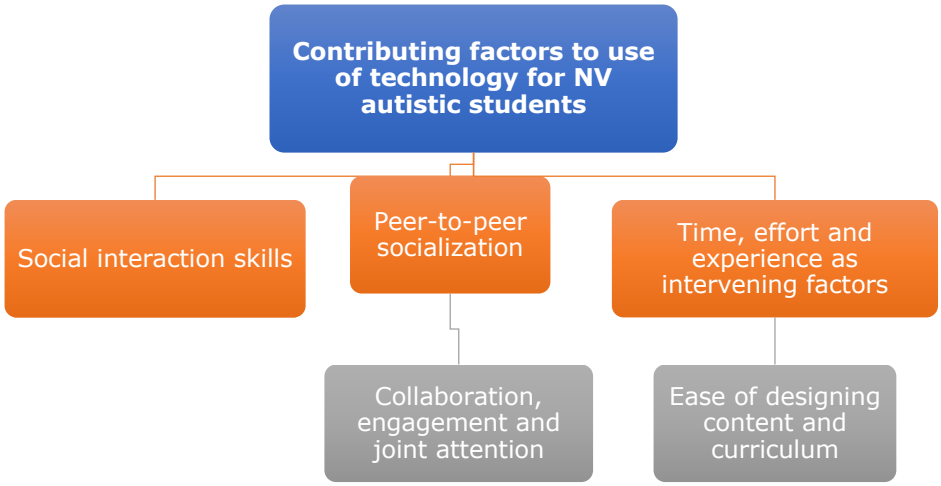


Figure 13 Themes obtained under RQ3 in School B

4.9. Contribution of technology to learning and teaching process

The effectiveness of technology is twofold, enabling both teachers and autistic students to make better efforts and practice SC – i.e., offering new perspectives for addressing multiple domains of challenges in NV autistic students by using technology in different ways and contexts.

4.9.1. Contribution of digital devices to social interaction skills

The use of technology to facilitate social interaction relates to the overall social capabilities of autistic students. The prominent teaching methods that facilitated social interaction using digital technologies were child-directed learning, scaffolding, intermittent interactions and feedback, discrete trial training, gradual guidance, transfer of learned skills, and rewards as reinforcement. Different strategies were also used by teachers in collaboration with tablets as visual aids and reinforcers to avoid the disruptive behaviour occasionally exhibited by students. Table 9 shows the different digital technologies and other strategies used by the teacher participants:

Table 9 Strategies to support NV communication skills

Participant	Strategy 1	Strategy 2	Strategy 3
Teacher 1	PECS Target skills: Accessing and picking up the desired card and handing it to a communication partner to communicate a request	Playing video on projectors	Tablets (scaffolding, peer mediation, graduated guidance, shadowing)
Teacher 2	Visual aids, flashcards	Audio aids, playing audio on tapes	Tablets (peer mediation, MKO, scaffolding, modelling)
Teacher 3	PECS	Speech-generating device (SGD)	Smartboards and tablets (peer mediation and graduated guidance)
Teacher 4	PECS	Speech-generating device (SGD)	Smartboard, tablet, laptop (social cognition through peer-mediated approach, contingent reinforcement)

The use of technology was found to improve different components of social interaction. In collaborative activities and games sessions, numerous actions were observed to assist the social interaction skills of these students e.g., when both partners accomplished a goal in

a game, they unconsciously imitated each other's laugh, smile and facial expressions (emotion recognition). One of the teachers mentioned that:

"The use of technology, in my view, addressed multiple social interaction functions such as joint attention, imitation, social involvement, gestures, cues, symbolic interactions, and many more."

The findings also revealed that by using technology-directed interactions, the teachers were directing their efforts towards one or more communication skills of the students. The very initial levels on tablet applications are designed to motivate cognitive skills that students already possess by practicing a single communication skill. They then advance on to more communication skills, as one of the teachers mentioned:

"The initial focus is to support their single-step initiation (e.g., touching a specific icon on the display screen) with applications on tablets, and then we move on to a more complex level of the application to produce other responses, i.e., answer questions by touching icons on the display screen."

Observation Summary

A collaborative tablet-based activity was observed where the application allowed students to play individually or in groups at different levels. Level 1 entailed matching the correct shapes, fruits, or animals on the tablets with the physical toys given to them. The more advanced level of the activity allowed two players to share a single animal toy and take turns to match the toy on the screen. The level was then further advanced by both players collaborating in the game and matching the toy with the screen cooperatively. If the students made an error, the teacher guided them, directing them by pointing at the screen or holding a hand. This was a technologically mediated activity that enhanced social interaction between both players, and it was further guided by verbal reinforcement by teachers. On winning the game, gifts and rewards were also given to encourage the students to learn and interact more. However, the intrinsic motivation to use the technology itself reinforced their desire to follow the instructions, although the teachers also used extrinsic rewards.

4.9.1.1. Peer-to-peer socialisation enhances collaboration, engagement and joint attention

The findings confirmed that teachers believe that establishing a group-based task prompts children to communicate (comment, point or request). Also, the pairing of a child with peers in a mainstream setting enhances engagement and collaboration, which also promotes their social emotional reciprocity. Hence, more balanced response and initiation

were recorded when a peer-mediated approach was adopted when using the device. One of the teachers commented:

"When peer networking is employed, it helps minimally verbal autistic children to express their needs with mainstream students who are more experienced in using technology. I believe peer mediation and adult instruction, from teachers or parents, through the right use of modelling and reinforcement, result in greater SC improvements."

This implied that the proximity created in a joint and collaborative learning/play space promotes the chances of joint attention and interaction. The joint learning session allows students to sit closer together to engage jointly. In other words, they look at the same screen or play the same application or game, which promotes joint attention and social orientation.

Collaboration has been identified as key in overall student learning, and social influences also have a significant impact on learning. Through the right choice of medium, effective collaboration between teachers and autistic students is found to contribute to overall social interaction and enabling communication in autistic students. Teacher 2 remarked:

"Yes, there are alternative communication programs that help children express their needs if they are trained and taught. I believe in focusing on the right use of technology to produce social interaction so that my efforts rely on 'attention', confidence (developing responsibility to operate on their own once they learn), relevance (matching learning styles with the motivational profile of the learner), and satisfaction (intermittent positive verbal reinforcement). Technologies are perfect for promoting perceptual interest, stimulating their inquiry, and maintaining their attention. Moreover, I make sure that the right set of strategies are employed to keep their visual and sensory interest stimulated."

This implies that the use of student-oriented instructions and strategies is imperative in establishing overall social interaction with the use of technology.

Observation Summary

To facilitate joint interactive learning sessions, serious games were played collaboratively in small learning groups (teachers, mainstream cooperative games, and other learning activities with peers). Video viewing sessions were seen to promote the duration of social interactions and social initiations. Imitation was observed when students were paired up in a group and one student used a tablet to make a request, which was imitated by another immediately afterwards, without supervision or guidance from the peer.

The next section reflects on how teachers at School B evaluated technological devices, tools, and technology-mediated instruction for NV autistic students in terms of time, experience, and resources

4.9.2. Time, experience, and effort with technological devices

Though efficient in terms of addressing various difficulties, a technologically mediated set-up for autistic students requires detailed technical and technological procedures, resources, and support. Also, the abilities and developmental profiles of each autistic student vary, and customising each application and program requires different technical settings and effort. However, there are also positive attributes of technological devices in this context, as mentioned below.

4.9.2.1. Ease of designing content and curriculum

Accessible, easy-to-use, and multipurpose digital devices have made it easy for teachers to make the transition away from manual ways of designing content and material. Customised programs can be designed on the devices, using simple guidelines, according to the learning needs of each autistic student. But some of the teachers also mentioned challenges with regard to finding applications in Arabic, and alternatives for students with different learning needs. One of the teachers elaborated on this idea:

"Although devices may ease the process of designing the content, when it comes to finding options for applications and programs in Arabic to be used with non-verbal autistic students, I find the options very limited. There are programs that can be purchased, but I cannot buy them on my own as they need regular subscriptions. So, I prefer conventional content as a variety then."

Hence, this infers that the ease of developing an accessible curriculum for autistic students facilitates teaching, as technology-based instructions can be designed quickly and easily. However, the limited options of applications and programs pose a challenge for teachers, which then leads them to employ traditional content as an alternative.

Relative to this, the contrasting view of some teachers was that, unlike traditional interventions, there is no standardised set of procedures for teaching autistic students how to operate devices and communicate using them. Instead, each teacher must determine the most appropriate way to implement the tablet, and steadily they find a path to success. With the progressing levels and acquisition of skills, the pace of both teachers and students increases. Therefore, this may require more time and effort, as teachers need more experience with each progressing level when using technological devices. For

example, more effort, experience, and time were required for practicing advanced SC skills with multiple steps (e.g., multiple word requests).

Teacher 4 mentioned:

"It may take more time and effort at the beginning, but after gaining experience with use, it becomes easier. If I compare the current device-based sessions to the traditional techniques, it is more efficient from many perspectives. Previously, it required a lot of physical effort exchanging pictures and moving to the communication book with picture strips, but now the handheld devices allow the student to make requests and comments with one tap."

The next section presents the barriers and challenges to using digital devices as a tool to support SC in NV autistic students. These centre on the accessibility and availability of resources and technology, and training facilities for teachers.

RQ4: What are the barriers and challenges to using digital devices as a tool to support SC in NV autistic students?

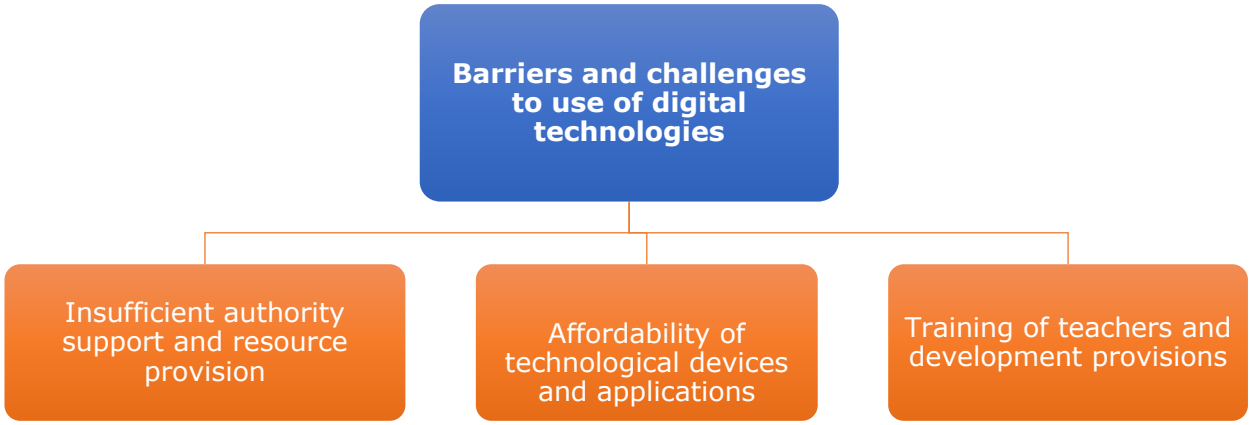


Figure 14 Themes obtained under RQ4 School B

4.10. Challenges to the use of digital devices

Given the SC difficulties of autistic students, teachers reported that they face considerable challenges to appropriately managing their time and regulating the use of learning through technology.

4.10.1. Insufficient authority support and resource provision

Reliable and regular access to technology is important for a learning session. The inability of autistic students to comprehend, understand, and develop familiarity with different aspects of technology is another challenge. Teachers shared a concern about the lack of effective support from authorities to help them handle the burden of selecting the right tools. Many applications are in the English language, and the teachers complained that this was one of the challenges:

"There is a lack of software and applications that support the [Arabic] language, so using all its features for the student is at times difficult."

For SC progress in autistic students, consistent use of devices is needed for practice and repetition. One device per student can overcome this challenge. However, teachers at School B reported a lack of devices and technical support from the school authorities. Teacher 4 and Teacher 2 reported that the support provided and the access to technological devices were inadequate – authorities need to look into this if autistic students' performance is to be improved:

"For me, the cost of equipment and software is too high to purchase myself. There is lack of provision of devices, in addition to the lack of programs and applications that support the [Arabic] language."

"I will count it as lack of attention from authorities. We lack and run short of required support materials and devices – the support continues, but it needs more development in technical human resources to monitor the use of devices. We don't know about troubleshooting and fixing damaged devices. Students lose pace, especially autistic students. It becomes difficult when device support is missing".

4.10.2. Affordability of technological devices and applications

It is important to mention that digital technologies are expensive, and therefore the affordability of these devices for students and teachers is a limitation. One of the teachers commented:

"The affordability of devices is easy at times, but the required applications are costly to the point that they cannot be afforded by families to practise the skills at home."

Another teacher commented:

"We have a new application suggestion every other day that offers more interactive features to address their communication difficulties, but the affordability is limited, and

authorities' support is inadequate in that context, too. So, we have to work with the applications available to us."

The affordability and cost associated with the devices are additional factors to be considered and they can hinder the attainment of optimum results for NV autistic students.

Timely support enables teachers to be more effective in integrating technology into their teaching for autistic students. The ineffective and insufficient monitoring by authorities relates to their lack of concern and ineffective attitude towards using technology for autistic students. Knowing that autistic student enrolment is increasing day by day, it should be their utmost priority to use technology, as communicated by national authorities.

4.10.3. Lack of parental support and cooperation

The findings revealed a lack of parental cooperation and support due to various barriers from the parents' perspective, as revealed by one of the teachers:

"At times, there are family status issues (stereotypes associated with the child's disabilities), concerns such as strict work schedules, and sometimes negative feelings about the use of technology. This is quite challenging, and we need parental cooperation equally in order to improve the child's difficulties".

Another teacher highlighted this barrier:

"Effective teacher–parent collaboration is missing, although we arrange parent–teacher meetings every end of the month to discuss various issues regarding their children."

This implied that teachers understand the importance of parental involvement and that parents know their children better and have a deeper understanding of their needs and challenges. Their support and collaboration can enable teachers to design instructions more closely matching the exact requirements of autistic students.

4.10.4. Training and development provisions

The findings illustrate that teachers recognise the importance of training for technology-based teaching for NV autistic students, but they reported a lack of support in this regard. However, they were motivated to learn and remain updated about the changing trends of technologies and programs for autistic students One of the teachers commented:

"Training on technological tools is crucial because we need it to keep pace with the global trends in the development of technology in the education context. It will help us to work with each student separately, according to the individual's needs, and track their gaps

more effectively. I keep myself engaged in independent learning through online resources available."

Another perspective mentioned was that in an inclusive educational setting, it is important to enhance teachers' competence in using technology collaboratively for both typically developing and autistic students. Teachers also identified online informal training sessions led by more expert teachers as a novel influential and time-saving solution. It can be useful to know how other professionals are using devices to support autistic students.

Teacher 2 highlighted this point:

"Being in an inclusive mainstream classroom needs us to be well-acquainted with procedures and novel ways of pairing autistic students with peers to help use technology in more effective ways. Training here plays a very vital role."

"I recommend that a blog is developed for teachers to share their concerns and information about their experiences with the use of devices, along with the most effective applications (apps). Delineating the apps that contribute the most to engaging students and delivering the curriculum delivery would be an excellent initiative. It would be more of a 'we-all-learn-from-each-other' environment."

The findings suggested that it is vital to narrow the knowledge and skills gap that may widen due to the difficulties that teachers encounter when using technical devices. Hence, the interviewees suggested that functional competencies should be addressed through periodic training provided by the school authorities.

The next section presents the findings from School C in the Qaseem region.

Case Study 3: School C (Qaseem)

4.11. Site description

School C, located in the north of Qassim, is one of the well-known institutions operating under the supervision of the MOE, providing learning programs for special education students, including autistic students. School C was selected based on its experience and tenure in addressing the learning and developmental needs of special education students in Qassim. The teachers and staff reported that a customised educational curriculum was being practised, i.e., it was tailored to meet individual needs, sharing the same learning profiles.

RQ1. ***How do teachers use digital technologies to support the SC in NV autistic students?***

This section elaborates on the findings related to the teacher's use of digital technologies to support SC in NV autistic students

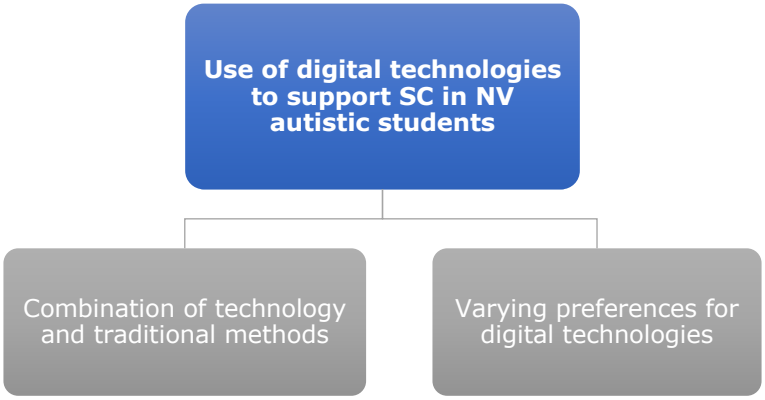


Figure 15 Themes obtained under RQ1 School C

4.11.1. Combination of traditional methods and digital technologies

The findings showed that the teachers believed in incorporating technology as a supplement to traditional teaching methods. They believed that effective learning and the responsiveness of autistic students were enhanced with the use of technological tools, as the learners may find them more motivating and attractive than traditional tools. Teacher 1 proclaimed:

"I have observed that digital technologies tempt them. With the absence of devices, we found that autistic students often find tasks boring and repetitive, and they may lose interest with regular techniques from the traditional pattern of learning."

A similar perspective of the findings is that technological tools and traditional methods are found to complement and supplement each other when combined. For example, the attention, focus, and motivation of autistic students were best managed by combining learning with the devices and learning through traditional means. Teacher 1 stated:

"Digital technology is quite complementary to the other teaching strategies. For instance, repetitive practice on an application through reinforcement and prompting increases the spontaneous communication in students who are non-verbal and non-expressive."

4.11.2. Varying preference for digital technologies

The most commonly used technologies were personal computers and projectors. Teachers had their own tablets, and some of the students had their own tablets, too. The selection of technology also varied from lesson to lesson and depended upon the relative ease and availability of each device for the students. One of the teachers commented:

"I prefer to rotate between traditional high technological tools, i.e., traditional desktops and laptop devices, and other advanced digital devices including smartboards and tablets depending upon their availability and the session need. But when it comes to the selection of technology based on preferences, we as teachers are interested more in the sleeker and more portable devices for autistic students."

Moreover, the findings from both the observations and the teachers' responses showed that multiple educational technologies were interchangeably used, depending on the group and individual session, revealing their experience with desktop computers, projectors, tablets computers, and smartboard technology. Student–teacher interaction observations also recorded the expertise and comfort level of teachers when using technology with NV autistic students. One of the teachers discussed the different tools he had been using:

"All technological tools have a different potential for practicing multiple SC skills, as well as assisting their motor difficulties of autistic students, e.g., projectors, interactive smartboards, and tablets. Also, they are preferred because of their reliability, social acceptability, predictability, and specification."

The availability and selection of devices were also based on their function and potential to suit each student. The ease with which a device can enhance collaboration and interaction is also considered, as is its ability to stimulate communication and enhance the participation of autistic students. One of the teachers responded:

"I prefer a projector and smartboard technology, owing to its affordability. Stimulation for children to collaborate with others in a group learning session enables them to overcome their social interaction problems."

The next section elaborates on the findings related to the advantages of technology tools over traditional methods for NV autistic students.

RQ2: In what ways do NV autistic students use digital technology for SC?

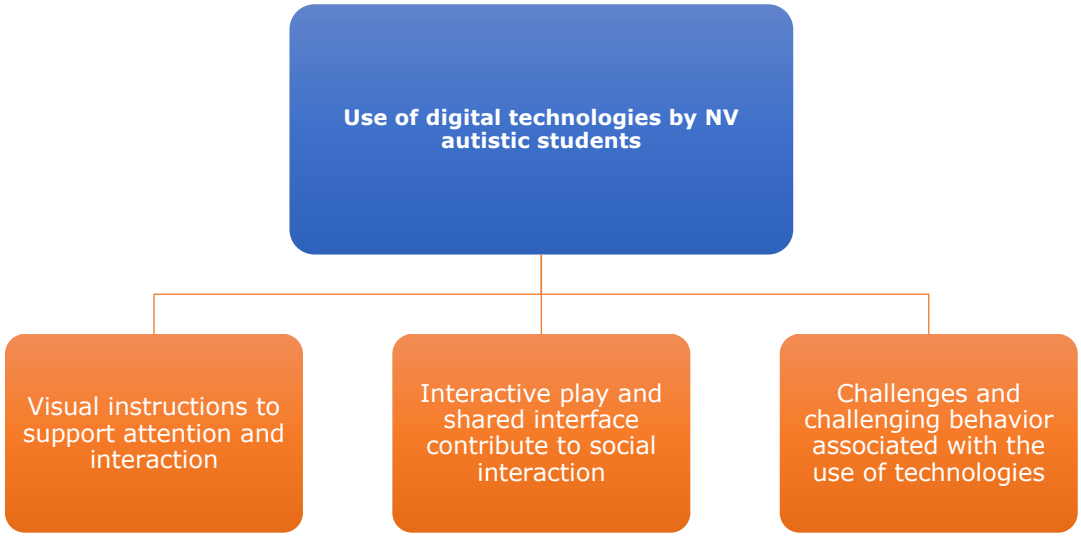


Figure 16 Themes obtained under RQ2 School C

4.12. Visual instructions to support attention and interaction

Technological tools support learning considerably more than traditional means by retaining the attention and interaction of autistic students. With traditional techniques and interventions, it is quite a challenge for teachers to retain the focus and attention span of autistic students. For example, it was observed that in a session using flashcards to learn responses, students displayed a lack of interest and were more easily distracted by the noise in the hallway than in a session conducted on a tablet where engagement and interest were stimulated by their interest in the screen.

"I believe these devices engage them through the attractive virtual medium, bright colours and clear visuals, which are favourable for autistic children. It keeps them engaged and enables them to practice activities and learning."

Another important perspective that added to the device's ability to retain attention was visual instructions. Traditional techniques and methods involve teachers' verbal

instructions directing students, whereas the interactive format of the device has more influence in communicating instructions and also enhances the retention of information for autistic students. Teacher 1 commented:

"When repeated instructions, visual cues, and modelling of the sound of an application or program are executed, it captures the non-verbal student's attention and directs him to express the sound and try to repeat/say that word."

The multimodal instructions given by the teacher, for example, sound and lip movements to encourage the student to learn phonemes and communicate, are not that efficiently perceived by the student as they generate less interest than simultaneous visual effects (audio, images, animations) on devices, which retain their attention. Teacher 4 explained:

"In a teacher–student interaction, we make unlimited repetitions of instructions; human capacities cannot afford as many natural opportunities to model/repeat the sounds for less verbal autistic students. However, prolonged practice sessions under guided monitoring can efficiently engage the students and enhance their expressive language skills."

4.12.1. Interactive play and shared interfaces contribute to social interaction

Interactive technologies are incorporated in different ways to motivate and assist the social interaction and engagement of autistic students, in the form of videos, learning, or playing games in groups. One of the teachers explained:

"We ensure that technology is not being used merely as a visual screen delivering passive stimuli, but is adopted as an interactive tool where these non-verbal students collaborate with mainstream students in shared game-based learning activities to direct their social interaction."

Teacher 2 commented:

"Yes, it contributes – they cannot initiate conversations and engage in social activities on their own. Collaborative activities prompt initiations to obtain an item or an activity of interest, or to obtain information to keep the student engaged with other peers in the collaborative activity."

Digital technologies maintain engagement through game-based features, i.e., rewards, points, feedback, and levelling up, which reinforce the student's learning span and patterns and enable attempts of language, appropriate behaviour, and multiple academic and social challenges. Teacher 1 commented:

"The intrinsic rewards and points in games help them to collaborate and learn expressions of joy and even sadness when they don't achieve a good score in the game. The

articulating scenes of a device motivate them to engage in drill and practice in the group, as well as independently."

In one of the collaborative game sessions, a participatory process was observed. Eye contact and shared activity were observed when teachers facilitated the collaboration of both players to move the puzzle pieces on a game-based activity, then allowed them free play. After mastering a level, they were rewarded by being able to watch any animated clip of their choice, or a mini-game. It was observed after completion of Phase 1 of a game that the game was paused to guide and instruct them verbally about Phase two. The students were asked to select an emotion for each face shown on a paused screen and then continue the gameplay. The autistic student was quite engaged and attracted by the possibility of cooperation with the other learner, and they imitated actions in the game and were allowed to take turns and interact more. Due to the small screen size and the large number of students, they huddled together to see the screen.

Correspondingly, the practices using shared interfaces were one of the potentially beneficial approaches discovered at School C, where a smartboard was used to facilitate social interaction between autistic students and their mainstream peers. A collaborative game was arranged to train autistic students with group work skills such as turn-taking, making requests, and initiating conversation, which increased their positive social interaction with peers after the shared interface session. This implied that cooperative sessions on an interactive screen allow engagement in versatile activities, increasing the exploration of the characteristics of the program they are learning together. Teacher 1 added to this perspective that maintaining these skills requires many technical prerequisites in the applications and programs used:

"I believe devices do engage students with their peers, but what is more important is the program's compatibility with each student's SC challenges. We lack Arabic-supported applications. Also, there are other technical gaps, and we lack the technical staff to help us update programs as per the needs of the students."

Another problem highlighted by the teacher was the overcrowding of students when a device was shared. Although social skills are supported when practiced, the shared physical space can be a disturbance in some cases. However, it can also be a means of facilitating joint attention, leading to greater social interaction with peers. Teacher 2 commented:

"If we are having a group session on a tablet in a small space, the overcrowding of students becomes frustrating to control. But on the other hand, this proximity brings them closer to their peers and helps them to overcome their prosocial behaviour."

Hence, this implies that technical devices do contribute towards prompting social interactions, but the integration of technology may not be a solution for every student in a given context.

4.12.2. Challenges associated with the use of technologies

Despite the use of technological tools to enable and support SC, teachers also reported the challenges and problems they encountered with the use of digital devices/tools with NV autistic students. The durability of the device was a significant challenge as it was observed that when the student was left with a device to practise a letter, he might sometimes turn on the device and start seeing his reflection, and at some point, begin unnecessarily touching and tapping the commands on an application. He may bang the tablet on the table, and the lack of a teacher assistant or another attendant to support him added to this problem. The findings revealed varying ways in which technological devices posed challenges for teachers who wished to use them for actual academic purposes, in terms of keeping the students focused on the lesson more than on other apps. Teacher 3 commented:

"We use devices with autistic students of varying ages, and some ages have no interest in devices. A student who is really interested in knowing the end surprise of the lesson/program, some may start to use a feature that is not meant to be used and get into other stuff like playing video games … so in these cases it is quite a challenge to achieve the actual goal of the application being used."

In addition to this, teachers also identified challenging behaviours, like the constant use and refusal to stop using devices such as tablet. Teacher 2 commented:

"They will not give it up if they have been zoned in on the device for a long time, especially when it is given to them as a reward after a lesson. I never want them to prolong the use that they get to the point of social isolation."

The findings from the teachers' responses and the observations revealed different factors that made the use of digital devices quite a challenge, e.g., using devices for facilitating SC, reinforcement; inadequate application design/features; and use of devices at home and at school. The audio sensory sensitivity of autistic students is also challenged by some features of the applications, as they may be loud or visually overstimulating, which irritates them, sometimes leading to challenging behaviour, as Teacher 1 stated:

"They are the sole user of these devices at home where they may use it unguided for other purposes, such as games and fun, so they may forget the actual purpose they are using it for at school."

In addition, Teacher 2 stated:

"There are times when there is some warning notification or message from the application that may cause a loud buzz when learning. This causes them to leave the device, close their eyes and put their hands over their ears. They may even scream or show other behaviour due to their audio-visual sensitivity."

An autistic student was observed in a session where he was given a tablet to watch a mini animation as a reward after he had learned some letters. The pupil was making quite an effort to close the game and switch back to the speech application to get the teacher's attention and communicate something. Teacher 3 identified that this was quite a challenge and they are kind of lost when they have to move from a game to an application to communicate something, For example:

"Having a digital device that is used both for playing games and communicating makes them feel chaotic when they have to communicate in between playing games because it is all combined on one screen for them."

The next section will highlight the findings on how different teaching methods and instructional strategies using digital technologies and devices can promote overall learning, as well as facilitate the teaching of NV autistic students.

RQ3: What are the factors contributing to the use of digital technology as a positive learning tool for NV autistic students?

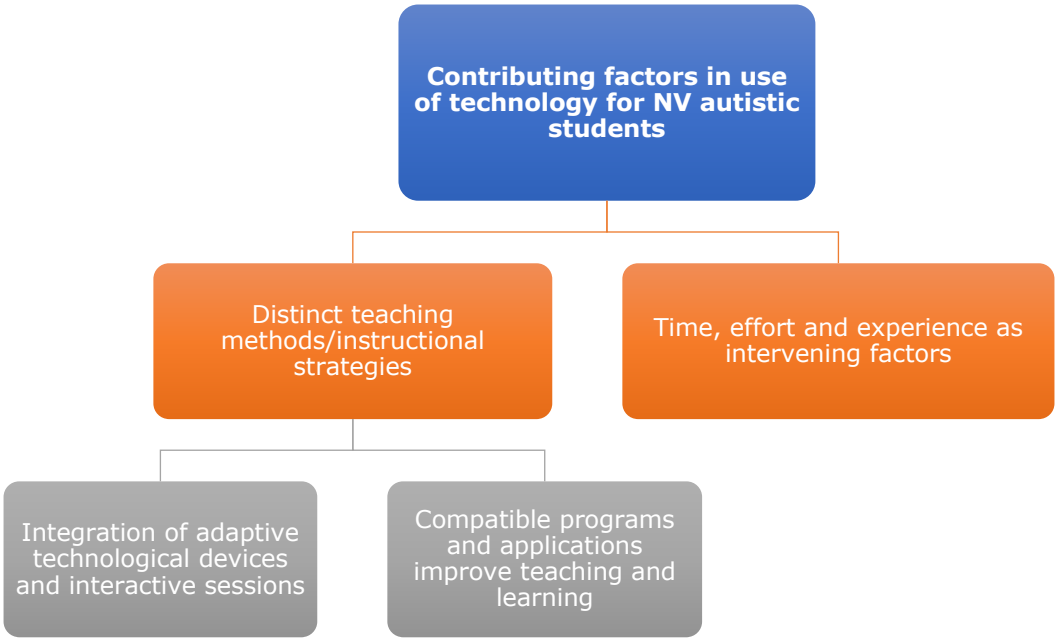


Figure 17 Themes obtained under RQ3 School C

4.13. Distinct teaching methods/instructional strategies promote learning and teaching using technology

Through the adoption of integrated and blended technology-based interventions and devices, overall learning and teaching processes for NV autistic students have become less laborious and more comprehensive. Different factors were explored under theme 2, forming subthemes that are explained below.

4.13.1. Integration of digital technology in interactive sessions

The findings from the teacher observations illustrate that the use of different integrated and adaptive technological interventions, along with their desired use and features as per the needs of NV autistic students, enables SC and desired behaviour. The level of engagement varies from student to student, depending upon the severity of their needs. Teacher 1 shared his views on this:

"For me, an adaptive and integrated approach augments technological device learning with other approaches for SC. For example, if a student is making slow progress in spoken communication through traditional methods, we practice different technology-based lessons using personalised application settings, increasing the level of difficulty for practicing vocabulary. In this process, he is prompted and can recognise words on the screen and use them in different activities."

Through this interactive learning session, they are not only practicing the skills but involuntarily getting familiar to other functions that add to their independence and self-confidence. Teacher 1 commented:

"In a learning session, where after 2–3 learning practice we fade away the support to observe and monitor the student's learning pace, we have seen that they learn to reach the desired page through the entire sequence of commands on the device under guided supervision. This is amazing – helping him with his motor skills, his cognitive wellbeing, and then the specific application that is enabling him to learn to speak and learn new words is another addition by providing him with voice output to motivate him to communicate."

Observation Summary

During a one-to-one session on the tablet, the teacher supported and worked with the student to retain his focus on the icons/pictures to be learned. This also involved different teaching strategies, i.e., least to most prompting; time delays using pictures that the child was interested in; and using reinforcement to encourage him to answer questions by touching icons/images on the device's display screen, for example 'What is your favourite snack?' The student tapped on fries on the screen, and also, when the picture of an apple was shown on the card, the student tapped it on the screen, hence supporting his receptive and identification skills to communicate.

This highlights how collaborative virtual and digital content has an edge for both learning and teaching. In the observation session it was recorded that autistic students with fewer verbal capabilities were engaged with technology-based learning, paying more attention to the screen content and exhibiting enhanced joint attention.

4.13.2. Compatible programs and applications assist teaching and learning

The findings discovered teachers usually incorporate verbal interventions combined with AAC approaches and many NV methods (interactive reinforcement systems) to help these students practice expressive language. So, through the right mix of technology and other methods, these students are encouraged to utilise their expressive abilities either through pointing, facial expressions or responding to commands. Teacher 2 commented:

"To increase vocabulary skills for less verbal autistic students, we use applications created with collaborative attention-gaining features, such as customised sound/voice generating effects, colours, animation, and music, along with external strategies, i.e., immediate contingent reinforcement for their social collaboration, language issues, turn-taking and sequencing of activities to regulate their behaviour."

This relates to the fact that versatile and child-specific applications developed on these popular platforms are considered by teachers to facilitate different skills of autistic students. Hence, multimedia applications and devices are a potentially suitable and inexpensive option capable of providing visual support along with verbal instructions that aid both learning and teaching processes to enhance the different skills of autistic students.

Observation Summary

A device-based lesson offered customised learning sessions, where along with technology, the teacher incorporated other techniques, including prompting, fading, errorless teaching, reinforcement through praising, and other verbal prompts. The session proved to be a productive one, where fewer verbal instructions and more technology-based commands kept the student engaged. His responses were more frequent and his learning span was promoted in each observation session. To further assess the role of technology in overall learning, the difficulty level of the program was increased. The application was introduced by the teacher, who then gradually withdrew their assistance. At the end of the game, upon successful completion of the task, students were rewarded with free game time or their favourite snack.

Hence, the findings implied that an appropriate mix of different teaching strategies and instructional approaches while using technologies prompts SC responses in NV autistic students.

4.13.3. Time, effort, and experience with technological devices

Different dimensions have been identified through the findings in this context. Technological support in enabling independent SC responses requires the time, effort, and experience of both student and teacher. Teacher 1 commented:

"It requires greater effort from both parties. It needs courses for teachers and also a double effort for students, but all of this is at the beginning of its use, and when experience is gained, the matter will become normal."

Another dimension highlighted by the teacher was technological knowledge and the need to gain more experience of using technology with MV/NV autistic students. Teacher 2 disclosed:

"It takes more effort on both sides. Courses for teachers are required, and students also need to try. But, these devices have the potential to provide advantages in terms of cost, availability, flexibility of use, and mobility."

Also, the maintenance of skills has to be monitored on a regular basis to determine the actual effectiveness of technology's impact on overall SC .

During the observation, one of the NV autistic students, who was practising making a request using the commands on the application, was checked for maintenance. He failed to make an independent and accurate response after one trial and had to go through several more practices again in the group as well as in an individual session. It took quite some time and effort by the teacher to maintain his response. Teacher 2 commented:

"There are times when students have to go through rounds of practice and sessions to master a skill using a device, and then we fade away our guidance and support to further see if they can manage alone. So, I believe with technology, it takes more effort and time with some students who face greater communication challenges."

The teacher reported that MV/NV students tend to learn new words faster on devices relative to when they go through unsupported learning by listening to verbal words repeated by teachers/parents. Teacher 3 shared his views:

"During my trial with Student B, the device enriched his vocabulary and motivation to learn to a greater degree relative to my efforts to make him learn new words through verbal instructions. His parents also reported the same."

Two contributing factors were identified related to this challenge of time and effort: the complexity of device and application design and features, such as certain inadequately designed applications; and the need for teachers to develop expertise so that they can guide the students in the use of the devices and applications. The findings indicate that teachers opted for simple applications that were operationally friendly for autistic students and allowed them to learn more in a shorter time. Teacher 1 commented:

"I have to explore and understand what the application/program does before I present it to them. Unwanted features impact the speed of learning and also divert their interest, so we ensure that we select programs with fewer complexities to achieve the desired goal. This is also less stressful for both the teacher and the student."

Hence, a simple interface with a compatible application will save time and effort and will be less stressful for both teachers and students. Moreover, using traditional approaches in conjunction with devices can help them to accomplish their goals in less time and with less effort. Teacher 1 elaborated on this perspective:

"Using devices and applications alone is not sufficient to improve SC, but if there are training on the use of applications for smart devices, it will take less time and effort, but

the experience will be required to strike a balance between traditional and technical field training."

Hence, the findings indicate that it is a two-way process that requires time and effort for the student. For teachers initially, it is challenging to use the right balance of technology and instructions, but with time the practice becomes routine.

RQ4: What are the barriers and challenges to using digital devices as a tool to support SC in NV autistic students?

From the perspective of teachers, the multiple challenges included a lack of adequate training and adequate support for teachers, inadequate funding of the required resources by authorities, and insufficient provision of technical assistance. Three important dimensions under these themes are training needed for teachers, support for students, and other technical barriers that need attention from the authorities.

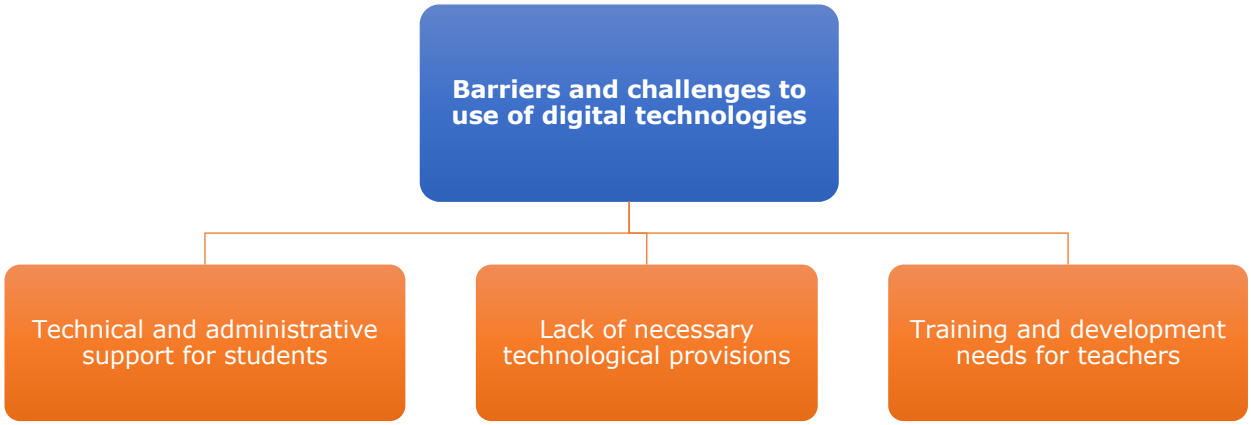


Figure 18 Themes obtained under RQ4 School C

4.14. Technical and administrative support for students

The use of technology to facilitate SC skills in NV autistic students is significantly linked to consistent administrative and technical support from school heads and authorities. If not adequate, the efforts and expertise of teachers alone may not address the challenges of these students. Two dimensions were emphasised through the interviews with the teachers: a lack of technical support and administrative attention.

The findings identified that the school administrators were not effectively maintaining the provision of adequate tools and other basic support. The teachers expressed the need for

assistance and direction from the administration and regional authorities to address the challenges of technology-based learning for NV autistic students. Teacher 1 elaborated on that:

"The amount of support may differ from region to region according to the education department or according to the school, but in my region and the school I am in, specifically, technical support and attention to it are unfortunately weak."

The teachers repeatedly identified the need for a holistic approach by the administration department, i.e., allocating resources – not only technical but also financial. That would further boost their morale and address the needs of NV autistic students. Teacher 2 shared his views:

"I believe in a continuum of support as it is not a one-time process but requires periodic up-grades of different things. I feel under-supported. The authorities need to allocate finances sufficiently to address the lack of devices in the classroom."

In this context, the findings indicate that teachers find it frustrating to lack access to technological resources (adequate devices in each class) and there was an identified need for administrative, financial, and resource support (allocating funds, financial resources, and access to training opportunities).

4.14.1. Lack of necessary technological provisions

The observational data confirms that teachers had to call off one session when a device malfunctioned and there was no technical staff available to address a minor technical fault. Also, the availability of devices was limited, and more were allocated to verbal autistic students than those who were MV/NV. This point was also asserted by Teacher 2:

"For me, the major barrier to the successful use of digital technologies is the availability of technological assistance and maintenance of the available devices. I propose that the authorities should purchase the devices at a concession rate from the governing bodies to tackle the availability issue, at least."

Another important challenge highlighted by the teacher related to visual distractions due to unnecessary sensory stimuli, noise levels, and lighting, which may distract autistic students from the learning track. For that, customised settings can be used, and attention has to be paid to keeping the students focused. Teacher 1 mentioned:

"At times, it is challenging when technical settings on devices are not favourable or matching the needs of the students. For example, there are no customisation settings for

all applications, so for that, we look to the authorities to upgrade devices or make devices available that are more efficient."

Teacher 3 suggested upgrading the system as a whole to yield maximum results for NV autistic students:

"The challenges are many, but their root causes are the same. I would say that these are the negligence of the school system, the lack of programmed applications for this field, the insufficient experience of some teachers to deal with such applications or devices, and the unwillingness to change the traditional methods that they are accustomed to."

Hence, the findings indicate that along with the benefits of using technological tools, there are also challenges and barriers that prevent teachers from reaching their full potential to improve the SC skills of autistic students.

4.14.2. Training and development needs for teachers

Although basic training to understand the general behaviour and challenges of autistic students is facilitated by the authorities, there remains a significant gap in helping teachers determine the full potential of technology. Teacher 1 commented:

"I think additional seminars, training modules, workshops, and courses advocating strategies for using technology are direly needed. We need to learn more about the effective use of technology with minimally verbal and non-verbal autistic students."

The findings reveal teachers' willingness to enhance their professional development, the need for provisions and support (digital devices and tools), and training for effective utilisation of technology. The need for training is critical because the profile of each autistic student is different. The devices cannot be executed in the same way with every student. Teacher 1 highlighted:

"Training is a kind of conduit for teachers. We need more courses inside or outside the school and training to understand and execute technological tools, but also with the provision of more devices. There is no value in training without also providing the means or support."

Findings revealed that facilitating training through networking of teachers with more experience across different centres will be more effective. Interaction of those with less

experience with more experienced teachers will enhance their confidence and also develop supportive working relationships, resulting in better use of technology for autistic students. Teacher 2 commented:

"I think holding courses and seminars and activating visits between different centres to exchange experiences with more learned teachers would be a great initiative."

Teacher 3 commented:

"A well-trained teacher knows when, why, and how to use technology, so for that, school authorities should hold workshops for teachers to benefit from each other's experiences and also activate communication between teachers from different centres to coach and mentor each other."

The following section present the cross-case analysis of findings from all three cases:

4.15. Cross-case analysis

- ***Educational curriculum, design, and technological devices***

Case A and B were conducted in Riyadh. Schools A and B had adequate facilities and resources due to being in one of the most prosperous cities in Saudi Arabia, whereas School C in Qaseem had limited resources, facilities, and provisions (devices, technical staff, and other teaching content). Despite the increasing developmental projects being undertaken in the city, the provisions in School C were not up to the mark of those in Schools A and B.

An IEP was part of the curriculum design across all three schools. A fixed set of courses must be followed for all students with specific modifications and customisation, according to the learning needs of the students.

The most commonly employed digital technologies were tablets and iPad with other technologies including projectors, smartboards, and laptops. The computer provisions were the same in all three schools and they were used more in the mainstream setting collectively for all the students, but tablets were primarily used individually in resource rooms, sometimes for group activities and sometimes for individualised sessions. The inclusion of autistic students in Schools A and B was facilitated by more teachers, whereas School C faced the issue of no assistance staff and a lack of facilities. There were not enough tablets in School C and teachers at times used their tablet to give instructions to

students. However, there was a lack of required programs and SC-specific applications in Arabic for these students.

- ***Preference for traditional techniques and digital technology***

Similarities: It was a common feature in all the schools that NV autistic students preferred to use digital technologies more than traditional methods of learning. The teachers in all three schools held the view that digital technologies supplement and facilitate the traditional way of teaching and make it convenient for teachers to direct learning and practice. In addition, they believed that digital technology (tablet computers) may engage students in social interaction and communication practices but that this may need to be paired with traditional strategies to predominantly support learning, social engagement, and communication in classroom contexts. In short, teachers did not view technology as a holistic solution to rely on to support SC in NV autistic students.

Most of the findings indicated that attention and engagement in traditional presentations are limited due to aversion to engaging in social interaction, but digital technology reinforces learning and encourages autistic students to engage in collaborative and shared interface learning activities (a less stressful learning medium)

Differences: Teachers in School 1 used technology more for fun and play-based activities. However, the teachers could not give individualised attention to each student at a given time due to the various learning profiles that required variations in the digital technologies for them to be effective. There was also a lack of technological provisions such as Arabic applications and an insufficient number of devices for the students in each resource room. Teachers from School 2 adopted digital devices as the student-centred medium to engage them and motivate them to support SC. In School 3, the teachers were more concerned about using technology on its own as a solution for the challenges exhibited by autistic students; due to their unpredictable behaviour they perceived that relying on technology alone was not a holistic solution.

- ***Progress in SC through digital techniques and strategies***

The findings suggested that technology mediation and group-based tasks can result in more considerable student engagement and motivation to communicate, compared with other times in the classroom when the devices were not in use. Teachers' instructional scaffolding did not retain the students' attention for long enough, but when technological devices were integrated into the learning, this won the students' attention and they could be directed to practise more in order to interact and learn to communicate. However, the teachers in School 1 did notice that different learning needs required individualised

attention with technology but that shared and collaborative practice (group-based learning) was more effective. Better collaboration and responsiveness were accomplished when the autistic students were paired up with peers, with similar challenges, as shown by the findings in School 2. However, that also posed various challenges for teachers, such as the availability of devices, which limited their ability to practise that on a regular basis.

It was elucidated through the findings that interest in digital devices can promote socially constructed learning through both formal and informal practices. Hence, the process appeared to support NV autistic students' SC, facilitating the conditions for learning through collaboration that further enabled what teachers saw as better-than-usual communicative behaviours. These are primary precursors of SC, including joint attention, social orientation, and interaction. For example, students used the features of an application to make requests, pointing, nodding or shaking the head, and looking from a person to the desired object (image on screen), indicating joint attention, which is an important precursor of SC.

- Similarly, the findings from School 1 and School 2 suggested that coordinated orientation towards an object through screen-based activities facilitates and accomplishes a shared 'mental state' in the participants. This is accomplished through the teacher's constant guidance and reinforcement (scaffolding) until the student is able to practise independently (ZPD). That further encourages regulation in the areas of receptive communication, expressive communication (use of eye contact, gestures, vocalisation, and facial expressions), and self-initiated social interaction. Relative to this, some teachers from each of the three schools ranked digital technology (see Appendix 2) as a partial but significant contributor to enable SC in NV autistic students, and some just considered it as a tool to engage the students in learning and they considered the role of instructions and their guidance more important for supporting SC.

- The findings from School C differ in this perspective as the teachers considered that technical issues and certain features of devices (unnecessary lights, colours, fonts, brightness, volume) would interrupt the attention and distract the student from learning, disrupting the collaboration directed towards SC.. Furthermore, they believed that technology-based learning does not work for all students. Some have more complex motor challenges, and some are more sensitive to audio-visual distractions. Hence, the preference for teachers' guidance and direction was prioritised.

- ***Factors of time, effort, and experience***

In terms of assessing the positive contribution of digital technology to the overall teaching and learning of NV autistic students, multifaceted responses were produced in all three schools that covered the aspects of time, effort, and experience with the use of digital technologies.

Teachers from School 1 elucidated that SC is supported more through technology- based practice, because the digital technology provides motivation and aids in increasing the student's attention and this reduces the time and effort required from the teacher. However, the teachers from Schools 2 and 3 identified that the learning styles of MV/NV autistic students are not uniform in nature, and that individualised learning of SC skills requires customised device-based learning, which requires more time, effort, and experience with digital technology. Some teachers in School 3 identified that MV/NV students could learn requesting behaviour with the traditional method (PECS) and produce the same proportions of requesting responses as with digital devices (tablets), but that it may take more time but fewer prompts. On the other hand, with technology, the learning effect may fade away when guidance is removed. Therefore, they emphasised that the maintenance and generalisation of independent SC responses, require the time, effort, and experience of both student and teacher.

- ***Multifaceted challenges of training, technical and administrative support***

Participants in all three schools reported various difficulties identified as common challenges with the use of digital technologies.

All three schools faced a lack of training facilities for the development of teachers' skills regarding the effective use of digital technology. The need to hold compatible courses, training and workshops was identified by the teachers. Teachers in Schools 2 and 3 reported a lack of support in terms of facilities and resources. Administrative and technical support were significantly weak in School 3 (maintenance and repair of devices, Arabic version of programs). School 1 had better facilities and support from authorities but it lacked follow-up on the provision of facilities.

The overall themes and subthemes are presented below in Table 10, followed by a cross-case analysis of the similarities and differences between the cases in Table 11**.**

Table 10 Cross-case analysis

VARIABLES	CASE 1 SCHOOL 1 (RIYADH)	CASE 2 SCHOOL 2 (RIYADH)	CASE 3 SCHOOL 3 (QASEEM)
Instructional strategies and technology employed	• **Scaffolding (prompts/reinforcers)** Each NV student varies in terms of least to most prompts, and most of them were successfully engaged to show some SC response and move to successive level of prompts with the use of digital technologies in sessions. • Independent: no prompts required • Verbal: needed verbal directives (Do you need a toy?) • Gesture: pointing to the required area to help the student make a communication attempt • Model: showing how to turn on the device and then allowing them to take initiative • Physical: hand over hand to make them learn • **Reinforcers**: favourite toys/snacks	▪ **Least-to-most prompting** (physical, verbal, non-verbal, gesture, positional prompts) ▪ **Graduated guidance**: physical hand-over-hand prompting, and fading of the physical guidance through shadowing and independence when the ability to complete the task is reached ▪ Teach one step until the student masters it (give enough support and then observe student performance until they need help again) (**ZPD, scaffolding)** ▪ Keep adding the new learning steps to complete the task learning **(Discrete Trial Training) e.g., upgrading levels of program/application on tablet activities** ▪ Verbal reinforcement (excellent job, applause) or extrinsic reward after the completion of a task, e.g., favourite toy/snack	Computer-assisted social stories, video modelling, imitation, responsive communication partners, naturalistic language strategies, prompting, modelling, and reinforcement.
EMERGING THEMES	• Integration of traditional and technological methods • Various effective teaching strategies • Mix of strategies and methods promotes SC • Varying learning profiles require variations in digital technologies • Persistence, time, effort, and teacher's experience of digital technology	▪ Preference for digital technology ▪ Convenience of use ▪ Preference of students ▪ promoting engagement and motivation ▪ Constructivist and cognitive SC ▪ Technology-based procedures are time consuming ▪ More time and effort to prepare	▪ Series of effective traditional and technology-based learning ▪ Visual instructions (multimodal) are more engaging than verbal ones ▪ Interactive play and shared interface contribute to social interaction

	• Positive teacher attitude • Administrative support • Training, technical and administrative support, and resources challenges	▪ Inadequate training. ▪ Technical and administrative support and resources required	▪ Challenges and challenging behaviour associated with the use of digital devices

Table 11 presents the similarities and differences of the findings across all three schools in terms of use of curriculum, layout, the preference for the use of technology, the extent of NV autistic students' regulation of SC difficulties, the impact of digital technology on time, effort and experiences and the challenges faced with the use of digital technologies.

Table 11 Similarities and differences across cases

COMPARISON OF FINDINGS	**COMMONALITIES**	**DIFFERENCES**
ACROSS REGIONS FACTORS	S1 and S2 were located in Riyadh and had adequate facilities and resources	Limited resources and facilities in S3 (devices, technical staff, and other teaching content)
EDUCATIONAL CURRICULUM, DESIGN, AND TECHNOLOGICAL DEVICES	Individualised educational plan (IEP) Digital technology (tablets)	School A and B had better facilities than School C, which faced issues of limited staff and facilities Lack of technological provisions in S3
PREFERENCE FOR TRADITIONAL TECHNIQUES AND DIGITAL TECHNOLOGY (TABLETS)	▪ Digital devices ***supplement and facilitate*** traditional teaching	**SCHOOL 1***: The focus* of the use of technology should be more on l***earning*** than fun/entertainment

	▪ Digital technology needs to be ***paired with traditional strategies*** ▪ Attention and engagement in traditional presentations are limited ▪ Digital technology ***reinforces learning*** and encourages autistic students to engage in collaborative and shared-interface activities of learning (less stressful learning medium)	**SCHOOL 2**: Digital devices are a student-centred medium for enhancing SC skills as they ***engage and motivate*** them to learn **SCHOOL 3**: MV/NV autistic students are unpredictable in behaviour; relying on ***technology alone is not a holistic solution.***
SOCIAL COMMUNICATION SUPPORT THROUGH DIGITAL TECHNOLOGIES AND STRATEGIES	▪ Shared and collaborative practices using group-based tasks through technology supports SC ▪ High levels of student engagement and motivation with digital technology Digital technology serves as primary instructional mode to retain attention, and support the precursors of SC, including joint attention, social orientation, and interaction	• Digital technology is seen as a partial but significant enabler of SC in MV/NV autistic students (S1, S2) ▪ Technical issues with devices interrupt and disrupt students' attention (S3) ▪ Uncertainty about the generalisation of skills learned through digital technology in different context (S3)
FACTORS OF TIME, EFFORT, AND EXPERIENCE	• Digital devices require more time, effort, and experience in content preparation • SC responses are mediated through interactive content on digital technology and saves time and effort for the teachers	• Individualised learning needs more time and effort • Traditional method (PECS) produces the same proportions of responses but takes longer (S3) • Maintenance of skills with technology unknown

MULTIFACETED CHALLENGES OF TRAINING, AND TECHNICAL AND ADMINISTRATIVE SUPPORT	• Lack of training for teachers (S1, S2, S3) • Lack of compatible courses, training and workshops • Lack of support for facilities and resources (S2, S3) • Lack of administrative and technical support (S3)	• Better facilities and support from authorities (S1) • Lack of follow-up on the provision of facilities (S1)

The following chapter presents the discussion of the findings in light of the extant literature.

Chapter Five: Discussion

5.0. Overview

The discussion chapter discusses the results of the interviews and observations in terms of what they reveal about the use of digital devices to support SC in NV autistic students in light of the literature, theory, and research questions**.**

The comparison of findings from all three cases explored the opinions and experiences of teachers and observation records related to the contribution of digital technologies as enabler and drivers of SC in NV autistic students. The manifestation of SC was explored in different structured or free flow practices through integration of tablet computers mostly that assisted in regulating the SC challenges-specifically accomplishing student attention and engagement leading to responsiveness in joint attention, social interaction and orientation. However, there were instances of practice and learning through digital technology that underpinned challenges. Moreover, the rich descriptions of the responses also illustrated factors related to NV autistic students, digital technologies, the teachers, and other contextual aspects that facilitated or hindered the effective use of technology. Findings also exhibited that through digital technologies (mainly tablets) developmental precursors of SC, i.e., joint attention, social orientation, social engagement, motor skills, and eventually ToM were motivated in NV autistic students. These precursors are the most fundamental factors of NV autistic students and are later linked to early language development and SC skills (Lord et al., 2015; Grossard et al., 2018). In the given context, digital technology was found to contribute to engaging NV autistic students owing to their natural interest in and affinity with visual processing and content delivered through digital devices (Shane and Albert, 2008).

Moreover, teachers from all three schools viewed other strategies (e.g., reinforcement, prompting, scaffolding, Discrete Trial Training, and time delays), used either alone or in combination, as important components in supporting SC. Additionally, there was support for the view that the use of technology cultivates interactive settings important for establishing joint engagement, social orienting, and social understanding in autistic students (Hourcade et al., 2012; Grossard et al., 2018), if used with the guided assistance and support of teachers. On the whole, positive outcomes have been indicated in terms of the efficacy of digital technology in enabling SC in autistic students.

Various concerns and challenges have been identified in all three case studies that constrained the effective integration and adoption of technology. It was observed and

mentioned by teachers that there is a dire need for effective training and development for teachers so that they can enhance their knowledge about the varying difficulties of autistic students and increase their competencies for practicing digital technologies so that they can be used to full advantage rather than just as a mediatory tool to supplement traditional methods.

In addition to this, the findings also illustrated the myriad ways in which communication and interaction in schools are influenced, for example, by the interests, preferences, and experiences of the teacher, the way in which the teacher scaffolds the learning, the features of the technology being used, and through a range of factors related to the learning needs of the student. A number of factors that had an impact on the students' interactions when utilising technology were noted by the researcher during the observations, and the thematic analysis revealed that these factors were related to the proficiency of the teacher, the developmental profiles of the learners, and the compatibility and design of the technology; there were troubleshooting difficulties and an absence of Arabic applications, and the teachers lacked the skills required to address the actual difficulties of the students. Moreover, the findings also identified that SC entails cognitive functions that are acquired in two stages: first, through interactions with others with more skills/knowledge (MKO); and second, through the integration of skills in an individual's mental structure through practice, engagement, and the retention of skills in a different context. These cognitive functions are the product of social interactions through the collaborative nature of learning and appropriate engagement of the learner in the learning process (through the teacher's guidance and mediated role of technological tools). The context of the current findings accords with Vygotsky's conceptualisation of Social Constructivist Theory. The findings identified that knowledge is co-constructed (under adequate guidance of teachers and collaborative learning that facilitates social interaction in the classroom). This links with the concept of MKO and ZPD through teacher's scaffolding (Vygotsky's conceptualisation of language development) (Vygotsky, 1962).

The findings also show that Saudi Arabia still needs to make improvements to integrate technology effectively for autistic students in mainstream schools due to the prevailing challenges, the most important being the lack of adequate training and development for teachers, government initiatives or support facilities, and technical challenges. This thesis discussed the core characteristics of NV autistic students, particularly their communication abilities and social interaction capacities, and related them to classroom practices and activities. It further assessed how the different aspects of the classroom, the curriculum, and teaching methods are modified to integrate digital technologies to support and enable SC. The findings, overall, showed that NV autistic students' SC as enabled and supported

through technology is a function of various variables, as each student is at a different age and learning level, and they have individual needs that must be addressed in a mainstream setting. In addition, technological integration alone cannot be valuable unless its use is guided by a proficient practitioner. Teachers need to implement a versatile approach and possess knowledge of using these devices to customise the functions relevant to the learning needs of NV autistic students.

The findings indicated that teachers had positive perceptions of technology use, but that their attitude towards technology did vary in ways that may be linked to particular challenges and factors which were expected to predict technology attitudes. These include the lack of professional development, lack of technical and staff assistance, lack of support from authorities, and inadequate devices.

The following section interprets the findings in light of the literature to elaborate on the interpretations.

RQ1. How do teachers use digital technologies to support the SC in NV autistic students ?

RQ1 aimed to explore teachers' use of digital technology to support the NV autistic students' SC. First, the findings obtained under this domain identified how the national curriculum was being modified to manage the difficulties and learning needs of autistic students, the availability of digital technologies in classrooms, and how they are used in learning sessions to engage students, supplementing and delivering instructions. Generally, a positive attitude was seen towards the use of technology; however, the teachers mentioned various challenges with the use of technology with autistic students. The views presented by the teachers resonate with past study findings, which highlighted positive attitudes towards the use of technology to support SC of autistic students (Chambers et al., 2017), but which also reported that the actual use of technology by teachers was limited by various factors that could undermine the integration of digital technologies into the classroom. The following section elaborates and reflects on these themes.

5.1. Modified curriculum and available digital technologies

In order to facilitate a supportive learning environment for autistic students, it is very important to differentiate the layout and the curriculum to match their learning needs. The mainstream setting in Saudi Arabia supports the integration of students with SEN. Depending upon the level of complexity, the educational setting and curriculum, along

with supplementary aids, are determined in a regular education setting (Al-Ahmadi, 2009). It was also observed that considering autistic students' challenges and keeping track of the interest of every student was quite a challenge for teachers due to the lack of assistance and additional staff in the classrooms. It has been reported by prior studies that the shortage of auxiliary staff in mainstream classrooms makes it challenging for teachers to manage autistic students alongside general students (Stephenson et al., 2021).

However, teachers make use of suitable and additional support, i.e., the educational curriculum was applied as per the strengths and capabilities of each student. Moreover, additional assistance was used to make the best of the curriculum to address their learning challenges, i.e., sometimes by integrating sensory and visual tools, and by making other suitable arrangements like changing the physical structure of the classroom (seating arrangement), creating interesting daily schedules, and keeping visual cues and instructions engaging. Almosoud (2010) stresses the need for a structured teaching approach for autistic students with a specific emphasis on four dimensions of teaching in an inclusive setting: physical classroom structure, daily schedules, work systems, and visual cues and instructions. The findings from this research identified that the general curriculum was modified, and tasks were incorporated to meet the complex communication needs of autistic students in Schools 1 and 2. Being in an inclusive mainstream setting, it was observed that the classroom layout and structure made it quite challenging for autistic students to get along with regular students in School 3. This corroborates evidence gathered by Aldabas (2015), indicating that there is no formal provision, only general guidelines for the education of autistic students in mainstream classrooms, which means that teachers lack standard guidelines.

5.2. Use and adoption of different digital technologies

Teachers held a positive perception of the adoption of technology on the whole. However, it was observed that using technology for instructional and learning purposes in an inclusive setting for autistic students had many challenges too. The classrooms were equipped with personal computers, projectors, and interactive boards, and students and teachers had their tablets. The findings indicated that tablets were mostly used because of students' preferences and the ease of portability of these devices. These findings corroborate prior studies which reported that the reason why teachers favour technology use is its ease of use for accomplishing educational purposes and the ability to avoid technology that is more complex to execute (Siyam, 2019).

The main digital technologies available in each school were projectors, interactive boards, personal computers, and tablets. There was a shortage of tablets and some teachers used their own devices; likewise, many students brought their tablet into the classroom. Moreover, the access to devices was further hindered by the limited availability of applications as the cost of buying relevant applications (specifically in Arabic) for autistic students was not covered by school authorities, and teachers could not afford to purchase them on their own. The shortage of devices has also been reported by Alanazi (2019), who reported that teachers had a positive disposition towards technology but were limited by the lack of provisions and support from authorities. The negligence of school authorities in facilitating technological provisions is further highlighted by prior researchers such as Alotaibi and Almalki (2016), who mention similar neglect by authorities, i.e., the lack of funds that limits teachers' access to easy-to-use technology to address the versatile learning goals of students. The authors further mention that the MoE in the KSA does not allocate or provide funding to address these issues. Hence, these factors may hinder teachers' inclination to integrate digital technologies into learning in the future.

The inadequate provisions from the responsible authorities are further accompanied by a lack of training opportunities for teachers. Teachers reported that they were given the devices without having any profound reason to use them or guidance on how to incorporate the tools efficaciously. Frequent training and professional development were lacking, which was reflected in the teachers' actual use of devices with autistic students. This shows that the authorities and management need to make improvements to manage the inclusion of autistic students in mainstream schools. Several primary issues need to be addressed: insufficient government initiatives and, possibly more essentially, a lack of teacher training on how to use technology to address complex SC difficulties in autistic students. The findings presented a mixed view of teachers' use of digital technologies. First, they hold positive perceptions of their ease of use, specifically tablets. However, they did not possess enough expertise to execute tasks on them effectively. They employed digital technologies generally in instructions, mainly for mediation, supplementing the content and motivating the students, and they used basic applications installed on the device to help enhance the SC skills of NV autistic students. This is contrary to prior findings that indicate that teachers lacking the professional knowledge of how to use technology are less oriented towards its use (Guillén-Gámez et al., 2021).

The findings of the current study further corroborate past studies on the importance of teachers' training and competencies. For example, Alabbas and Miller (2019) discussed how teachers' lack of competency and required skills in the use of technology can be challenging in a classroom context. In a similar context, Almethen (2017) suggested that

the provision of training is mandatory to upgrade teachers' skills and expertise. The constraint of training is one of the major factors limiting Saudi teachers in the effective use of technology. The findings of this study also elucidate that teachers were willing to attend training provided that the authorities arranged it, but their failure to facilitate provisions limited teachers' use of technologies to address the context-specific challenges of autistic students, including SC difficulties. The teacher participants also mentioned that they would only be able to fully realise the potential of technology for students with SC difficulties when they were given training and updated with recent developments in the domain of digital technologies for NV autistic students. The teachers were motivated to progress the existing learning and teaching by augmenting their approaches with technology to manage the challenges of NV autistic students. The preference for the use of traditional methods and technological tools or a combination of both constituted a major theme under RQ1, which is elaborated below.

5.3. Preference for traditional techniques and digital technology

The findings identified that teachers from all three schools were inclined to use a combination of approaches, i.e., traditional strategies and methods along with technology, to promote opportunities for practicing SC in NV autistic students. This study has also demonstrated that teachers with a positive orientation towards the use of technology were also motivated to use traditional methods and tailored instruction because they considered this approach to be a fundamental characteristic of special education practices. This was further supported by the notion of 'no one size fits all' mentioned by teachers at School A. There is a need to adopt various effective teaching strategies to address a different repertoire of communication skills in autistic students**.** In other words, it can be stated that no single intervention, strategy, and single digital tool can contribute individually and effectively to regulate SC challenges in NV autistic students, as each of them varies on the autistic spectrum. This ascertains the notion by Wong et al. (2015) that the most beneficial approach to addressing SC challenges is one that considers a combination of different empirically proven methods. Most of the findings indicated that attention and engagement in traditional presentations are limited due to aversion to engaging in social interaction, but digital technology reinforces learning and motivates autistic students to engage in collaborative and shared learning activities of learning, as it is a less stressful learning medium. Some teachers preferred digital technology (tablets computers) for their convenience of use and preference by students, and because they enhanced engagement and motivation and underlying affinity of students towards the digital technology. However, according to the observation data, digital technologies were incorporated mostly

to engage, reinforce and reward the student for showing the desired behaviour. Teachers also used tablets for supplemental instruction; traditional methods to promote communication, i.e., flashcards, PECS, signs, and gestures, were seen as the primary method of instruction. Different supplementary materials like these are useful potential aids for NV autistic students, as mentioned by Kasari et al. (2014), and using a variety of NV communication methods helps them to utilise speech and language with practice and time (Merinda, 2009).

On the one hand, teachers mentioned a preference to use technology for it offers a more interactive interface and attracts the attention of autistic students, but on the other hand as recorded during the observations, they countered various challenges, i.e., a lack of confidence in using the tools for teaching while administering them with NV autistic students. Also, they were clear that their human role was more important when instructing students and they did not wish to rely solely on technology for practicing communication skills, as technology alone cannot be a holistic solution. This finding reinforces previous research (Merinda, 2009; Kasari, 2014) that accommodated different types of interventions, which may have or may not have aided speech and language in NV autistic students. The findings also indicated the use of traditional signs, graphic symbols, flashcards, and PECS as supplementary materials in all three schools, along with new digital technologies. The use of the blended approach is also supported by Watkins et al. (2017), who described it as a significant 'technical eclectic 'approach for autistic students. Using both traditional techniques and a technologically mediated approach is an effective and promising way to manage SC needs and the array of difficulties in NV autistic students.

Additionally, another perspective that is reflected through these findings is the multi-component nature of using a mixed approach. Using both traditional and technological mediums makes it difficult to differentiate specifically to exactly manage the targeted difficulties and produce favourable outcomes for students. Digital technology is best used in integration with regular teaching instructions and intervention strategies rather than as a replacement for them. A commonality prevailed in all schools, i.e., digital devices supplement and facilitate the traditional way of teaching and make it convenient for teachers to support the learning process and direct learning and practices through devices more efficiently. Digital technology (tablets) may engage students and prolong their attention span for communication but it may need to be paired with traditional strategies to direct their collaboration and learning in the classroom context. This view accords with Cumming and Rodriguez (2013), who supported the role of the tablet in promoting academic engagement and further facilitating opportunities to practice language activities in autistic students. Another important finding relates to the use of two to three mediums

or, as Allen et al. (2016) called it, exemplars (2D and 3D) that it adds to the improvements in the communication skills of NV autistic students. The findings illustrated occasions when teachers were using 2D flashcards, then showing that picture on a tablet and then at times in a real-life context too to check if students could label them in each context and develop associative learning for each context. This approach also relates to how the technology-mediated support for SC is more beneficial than rigid ways of traditional means and learning tools. The findings of Allen et al. (2016) mention a similar dimension that using multiple exemplars aids the labelling and receptive communication responses of NV autistic students, specifically when they are shown the 2D image of an object on a tablet. If the applications are designed effectively to use graphics that resemble the object, they will support the learning of autistic students more efficiently.

The following section discusses the use of a modified general curriculum in an inclusive setting in different schools in Saudi Arabia. It further emphasises that modifying the general curriculum in an inclusive setting is a mandatory approach to align with learning needs and for managing difficulties in autistic students. Teachers in all three schools had varied levels of experience and expertise. Most of them were not adequately knowledgeable about how to use technology or what suited autistic students the most, and they incorporated the strategies and tools equally for both verbal and NV autistic students.

5.4. Use of digital technologies with instructional strategies

In other cases, where digital devices were adopted as learning tools, efforts by teachers were directed towards balancing the attention between the student, teacher, and digital devices, cued by eye gaze, gestures such as pointing, and verbal cues, and through the use of instructional strategies, which mostly included scaffolding, prompting, and differentiated reinforcement - that facilitated the technology mediated activities to enable SC in NV autistic students. Prior research supports the use of a mix of strategies and systematic instructions that have different impacts on engaging students and potential gains in communication throughout the learning process (Watkins et al., 2019) along with incorporation of digital applications. Kagohara et al. (2013) mentioned how NV autistic students learned a complex communication sequence, unlike a single request function, through explicit teacher instructions and a mix of strategies. This indicates that a collaborative and combined approach to instructing NV autistic students can enable their communication profile and aid their SC interactions. This aligns with findings of current study that identified that to facilitate technology-mediated learning and collaboration between students to support SC, teachers made use of explicit instructions, verbal

guidance, and explanation. However, it was observed that for NV autistic students, teachers had to incorporate more coordinated actions (modelling the actions like showing how to turn on the device and then allowing them to take the initiative) and gestures (pointing to the required area to help the student make communication attempt). In addition to the provision of guidance and instructions to enable SC responses, students were aided with prompts (verbal and physical), reinforcers, and strategies like video modelling, responsive communication partners, naturalistic language strategies, prompting, and reinforcement. The regular and successive learning practices enhanced their independence and communicative responses. The preference for a digital device is also shaped by its affordance of customisation features that are not available in traditional paper materials and are a means of managing the communication challenges. The findings exhibited that the ease and convenience of using, modifying, and changing the content on a digital interface are some of the contributing affordances that shape the choice of teachers and learners to choose it over traditional means of learning and teaching. Also, for autistic students with varied and versatile complex communicational and social needs, this affordance is of critical importance, as the personalisation of content can enable a possible solution for different learning styles and variations.

The findings indicated that the interest of autistic students in visual media and devices relates to their affinity for device and interactive content. Teachers pointed to the fact that technology-based learning is more attractive to them for the ease it offers, the fewer transitions involved, and the reason that it offers a student-oriented pace. The use of a one-on-one structured, predictable, and controlled environment through the use of technological tools facilitates joint attention, social interaction, orientation and to link to their peers for better ToM that further enhances the comprehension and awareness of the student.

The findings from both the interviews and the observations further demonstrates that significantly less effort is required when practicing through technology-based activities and there is no need to make major changes in position from one exercise to another, as in conventional methods. The applications and programs can be used persistently and repetitively depending on interest of the students. With this perspective, some teachers were concerned about the visual and sensory load that devices may put on autistic students and may distract them from the learning route. This finding accords with Giallombardo (2022) that keeping in mind the sensory needs and sensitivities of autistic children, there should be sensory warm and sensory friendly tools and features on a digital tool. Contrary to this opinion, Chen et al. (2012) mentioned in their study how technology's graphics, colour, and visual brightness capture and retain autistic student's attention and

mention it as a core feature for design features of applications for autistic students (Alcorn et al., 2014).

Collaboration is significantly motivated and sustained through verbal expression and dialogues. For NV autistic students, the implications are different in terms of how and what could facilitate their collaboration with their partner in a technologically mediated session. The findings align to the use of technology as an artefact that is supported in Vygotsky's theoretical model of the sociocultural theory. Specifically, it refers to the use of cultural artefacts to support collaboration, with the technological interface (Kim, 2013) serving as a medium of communication and different communication functions exhibited as turn-taking responses, comments, and labelling certain features or expression of emotions through using the right button (Ridgway, 2013). This relates to Vygotsky's view that development is significantly linked to the tools involved in the learning process that enable the student to move from an inter- to intra-psychological state where the student and teacher interact with learning through adequate guidance and support in the student's ZPD, leading them to perform the task independently; this whole collaboration is supported by the teacher's guidance (scaffolding) (Wood et al., 1976).

The findings from the research indicated that during different trials and phases of using technology, teachers employed verbal/physical prompts that faded with successive trials and enhanced students' independence and communicative responses. It was observed that each NV autistic student varied in terms of least to most prompts (physical, verbal, non-verbal, gesture, positional prompts) with each trial (performed 5–6 times in a session and approximately 20–30 trials in total to maintain the acquired response, as reported by teachers in general), and most of them were able to move to the next levels. Moreover, to enable the students' communication responses, teachers were observed adding new learning steps by adding difficulty levels in games, followed by verbal reinforcement (applause and praise) as a social reward to retain the response (Schuetze et al., 2017).

The major affordances of digital technologies, specifically tablets, was the ease of interaction for autistic students mentioned by teachers and observed as well. The direct access of digital devices and practice on them allowed for the easy exploration of features and learning by the students. However, teachers also consider it a challenge if the device does not have a controlled access option, as the tablets have. Otherwise, students may be distracted by other programs on the device. In addition, the teachers also mentioned that the self-contained nature of tablets might limit face-to-face interaction in group interactions and multiple user activities. Therefore, the role of teachers was significant to ensure responsiveness and coordination through the simultaneous monitoring of students while practicing together on shared screens. Moreover, it was observed that natural

interactions on these screens aids in practicing fine motor skills and imprecise manipulation, and provide NV students an opportunity for interaction. They applied the rules and skills from the previous level to the next level tasks.

Relative to this, prior studies consider other digital technologies to be more favourable, connecting to the aversion shown by autistic students to perform in a small space and with a small screen. Chen (2012) mentions that it is a complex task to execute a tool for autistic students whose sensory tolerance and level of motor abilities vary. The findings illustrates that the teachers did not preferred using a traditional mouse and desktop computer, as there is an additional barrier between the students and the learning interface. While technology-based practices through collaborative screen of tablet computers allowed for more natural interaction and also enabled practicing motor skills and sometimes imprecise manipulation, mouse pointers require careful motor skills and manoeuvring to operate. When using traditional techniques, the direct manipulation of objects (using oral, visual, and tactile senses) is challenging. However, while using a device interface, students can explore the possibility of non-verbal and gestural communication through different features of an application as well. The interactive features of technological tools allow for engaged interaction that even offers customisation of font size (object) on the screen and enabling features according to preference and suitability of student relative to pre-designed manual signs and cards.

The most frequently used devices were tablets (for individualised learning), relative to projectors and smartboards that were frequently used for collaborative and videos based learning sessions to practice for SC. The preference for tablets computers have been shown, as supported by Nuernberger et al. (2013), who found that the use of tablets and handheld devices are more effective for directing students' learning behaviour as well as enhancing instructions through a digital medium. The findings also elucidated how students could be engaged on-task, and using tablets allowed for feedback during the task execution that was more immediate and frequent. Further, these interfaces facilitated easy and frequent practice and repetition, and enabled communication responses in autistic students. This digitally mediated practice further accelerates one-on-one assistance for students that can be more difficult to achieve, and teachers can manage this in a mainstream inclusive context. Furthermore, teachers incorporated digital technologies differently, more as a tool to enable and enhance the classroom instructions. For instance, some teachers incorporated tablets to prepare students for learning by watching content relevant videos with them.

Teacher's views further aligns with past literature on how digital technologies, specifically tablets can be. incorporated to enhance the teaching methods for autistic students.

Chambers et al. (2017) mention the flexibility teachers feel delivering the instructions using technology. This connotes to the findings in observation sessions where teachers were flexible in using devices to deliver instructions, whereas they had to be more diligent when using traditional instructions or methods. However, they faced many challenges, too, including the incorporation of devices when they saw students were losing interest. The results also support the earlier findings that showed that the ease of use of digital technologies (tablets) and their flexible portability encourage learning in students, allowing teachers to transition the instructional medium from teacher-oriented to student-oriented (Pruet et al., 2016). Hence, in doing so, students were assisted not only with the verbal instruction and teacher's guidance, but also of the technology-mediated facility and also their progress time to time (Lathan, 2020).

Another important concern mentioned by teachers is the perceived lack of control if they allow the use of technology relative to conventional learning practice. Ozdamil and Hunzen (2017), also acknowledged that the balance between teaching and the use of technology should be maintained. For instance, it was evident at some points that the technological session lost its flow and balance of student's learning and engagement due to troubleshooting and other technical errors. These results further relate to the barriers identified by previous studies, such as the lack of comfortable use of technology due to inadequate knowledge, and technological literacy may impede the effective use of technological features to align with other teaching methods (Hamilton, 2015; Simard and Karsenti, 2016)

The findings elucidate that digital technologies hold the potential to enable SC practice and responses (such as communication gestures, interaction in shared and collaborative sessions, initiation responses, independence, and engagement, and requests) in NV autistic students, but the approach of using traditional techniques and their significance cannot be ignored. Teachers positively perceive the contributory role of digital devices in the classroom to support SC, but communicated many concerns linked to the appropriate adoption of technology. However, the role of technology as a mediatory tool, facilitative medium, and reinforcer in their instructional approaches, along with other strategies and interventions is manifested. This role of technology as an enabler accords with Maseri et al. (2021), who reported better reinforcements made with the use of interactive tools in an intervention executed for autistic students, provided that it was used for a longer duration with multiple trials.

The following section discusses the findings obtained under Research Question 2 in light of prior literature and theories.

RQ2. In what ways do NV autistic students use digital technology for SC?

The findings obtained from all three schools explored how digital technologies (tablets) were used as an interactive tool to support SC in NV autistic students. It further explored how these students engaged with the use of devices to communicate their needs and wants. Moreover, the findings also recorded responsiveness and different instances of SC by NV autistic children with the use of a given technological device (e.g., joint attention while playing a common game/learning through the application). The findings further described the role of the teacher's expertise and attitude (support and repetition of instructions) while using tablets to help students with social communication challenges in an inclusive setting.

5.5. Impact of technology on SC of NV autistic students

Critically, the study mainly focused on NV verbal autistic children because they constitute a major population of autistic children and are not well researched in prior studies. The observation session indicated that these students lack symbolic comprehension and fail to attribute names to objects when placed with their pictures. However, it was observed that their comprehension is considerably impacted by the type of interface being used to show the pictures, i.e., traditional flashcards vs. the interactive screens of tablets. This verifies the view presented by the findings of Hartley and Allen (2014b) that symbolic understanding influences the communication capacities of NV autistic students. So, the visual representation medium also determines their learning and engagement with the lesson. Pictures of objects of their interest shown on the tablets won their engagement and attention.

The findings disclosed that teachers find technology mediated teaching a positive and supportive way to engage students in learning activities through available resources to enable SC. The teachers perceive the use of digital technologies as prompting the targeted SC of NV autistic students because they keep their role and contribution active with the use of effective instructional strategies (Besler and Kurt, 2016). Major preference was given to tablets due to the attributes of ease of use and availability to students. This is supported by prior studies that found that the tablets are mostly used for its easy interactive features and is highly engaging in developing various skills in autistic students (Fletcher-Watson et al., 2016; Kagohara et al., 2013). However, they would not rely on devices alone for assisting SC, but rather accommodate a lot of verbal instructions and other support such as visual cues and pictures to avoid the mere reliance on devices.

Moreover, students were also given tablets as a reward to reinforce certain desired behaviours/responses.

The different activities that were observed to practice SC among NV autistic students included their ability to communicate their response, labelling and pointing to images of the object they want, and showing their response by labelling the right pictures on the tablets. Prior studies have potentially supported the role of digital devices in producing the 'request' skill in NV autistic students (Simpson et al., 2015). In addition to this, the observation session recorded that after a collaborative game session and achieving certain points, students smiled at each other, showing their emotional response after using the application and indicating how they felt and exchanging that with their partners. Moreover, it was also found that they initiated their needs and wants by tapping on the picture displayed on the application on the tablets. This indicated that devices play a contributory role in supporting the expressive language of MV/NV autistic students.

Brignel et al. (2018) posits that the responses achieved under the domain of expressive language among MV/NV students can range between different expressions, e.g., they may request or comment on something through different sounds, pointing, words, phrases, or sentences exhibited in other various ways. However, prior studies have also demonstrated the improvement in the expressive communication of these students, also achieved through automatic reinforcement using devices. Kasari (2014) suggests that devices hold the potential to reduce the pressure on NV students to be vocal and indirectly direct their chances of being spontaneously vocal. In addition, digital technologies facilitate and present visual and auditory features simultaneously for NV students as a reinforcer to stimulate word production with repeated trials. However, this was not indicated by the findings of the current study, which may relate to enhancing systematic support and training resources for teachers to have confidence and knowledge for better SC relevant practices on digital technologies. This limitation further entailed the limited available programs and applications in Arabic.

Kagohara et al. (2012) stress the role of the teacher in their time-to-time support through verbal instructions and the use of external prompts and reinforcers to enhance students' ability to yield the communication response. The findings highlighted teachers' active role in providing external support for young autistic students to guide them on using devices, as the students were not capable of using them independently, and the teachers model the use by performing the task themselves first. In some cases, the teachers also accommodated the use of PECS and other signs and flashcards to retain the learned response in other contexts. They also monitored students' progress from time to time,

including supporting and scaffolding the student. Moreover, they reduced all external distractions that may confuse or overwhelm the students and cause them to lose track.

The overall implication of this finding is that digital tool integration was there, but was constrained by many limitations, that emphasises concerns regarding educational provisions and instructional techniques, providing valuable perspectives on the factors that influence teachers' decision and use of technology integration and the significance of enhancing their technological abilities and understanding., The findings do not provide substantial evidence for the influence of digital technologies on learning outcomes, they show significant evidence for engagement and supplementing instructions. This point illustrates Higgins and Siddle's (2016) view that this may relate to the way technology has been used; additionally, Major et al. (2018) mentioned that technology was just used to support the available instructional methods and to keep students happy or engaged.

The findings obtained under RQ2 add to the previous literature on how NV autistic students engage effectively with tablets and how this enabled their behaviour towards SC responses through teachers' support. Vandermeer et al. (2015), indicated that tablet use can increase communication for autistic students through the use of interactive pictures and word matching, leading to positive and spontaneous responses as precursors of SC (Vandermeer et al., 2015). Similarly, the findings of the current study indicated how practice using digital technology enabled communication responses in NV autistic students through least to most prompting and guided assistance by the teachers. By using various features of the app to request their preferred item and activities, they were able to interact – initially through the teacher's support, and then independently with no peer or teacher directing them to initiate the response, exhibiting SC. This finding aligns with Xin and Leonard (2015), who acknowledged the role of digital devices, especially the tablet, in improving communication responses. However, other studies highlight the importance of time-to-time prompts with the use of the device to initiate the communication response by NV students even after certain trials (Fletcher-Watson et al., 2016). This also reflects the importance of variables associated with directing students towards learning while using the tablets and not just as a means of keeping them engaged.

5.6. Joint learning session to promote social interaction

Social interaction is a demanding effort for autistic students and one of the foremost challenges that impede their successful inclusion with peers or people surrounding them. The findings demonstrated the role of digital technologies as a mediator in the facilitation of SC and supportive social atmosphere through the teacher's assistance and doing various

practices and activities; such as role-playing of the skill to be learned (e.g., turn-taking, sharing, and conversation skills) to redirect the students towards certain actions and to complete the task (Landry Fukunaga, 2011). It was recorded that the joint interactive learning sessions that were accomplished by pairing an autistic student with a knowledgeable peer in games or watching videos helped practicing their SC responses. Spontaneous verbal initiations, responses, and the duration of social interactions was observed as well. Peer-to-peer pairing was also found to support social motivation and interaction. Imitation was also observed when students were paired up in a group where one student using a tablet to request the application was imitated by another immediately afterwards. The findings suggest that maintaining engagement through coordinated peer-to-peer game-based features, e.g., rewards, points, feedback, and levelling up, reinforce the student's engagement led learning span and enabled targeted SC responses. Teachers reinforce appropriate social behaviour to encourage interaction with others through certain motivators that further increased their determination.

According to the findings, the NV autistic students demonstrated interaction without being vocal, but through shared understanding. The digital technology provides a collaborative medium and coordinated actions to contribute to understanding, shared action, and regulating behaviour, such as turn-taking in a game played mutually by students. Hence, the appropriate incorporation of digital technologies in communication based on a sociocultural perspective could facilitate students' social interaction, especially for NV autistic students. Prior research has also indicated that a coordinated activity in an interactive digital medium enhances coordinated moves and contributes to joint engagement more than free independent play (Fletcher-Watson et al., 2017). However, a challenge mentioned by some teachers in a shared interface is that autistic students exhibit an aversion to proximity when they have to share a small interface, but prior research shows that practicing this over time can overcome this issue when students become more familiar with their activity partner (Boyd et al., 2015).

Autistic students have different levels of social difficulties and the extent varies from verbal to NV autistic students. When it comes to NV autistic students, it is of more concern to facilitate motivating or engaging environments that encourage interaction. Keeping in view students' preferences, activities led by their interests should be facilitated and provide a space that suits the learning style of autistic children (Fletcher-Watson, 2014), as it will provide opportunities to use social skills. These findings corroborate ideas presented by prior research that found that digital devices are the medium of common interest for autistic students (Clark and Adams, 2020; Grove et al., 2018), but it goes against the notion of physical space suitable for autistic students, as being in an inclusive setting is

not always appropriate for these students who need more intense attention and individualised support from teachers from time to time.

The findings also established that the proclivity of NV autistic students to use tablets is associated with their ease of use and the students' eagerness to use the device as they know it helps them in communicating their needs/wants. The teachers associated the factors of attractive visual graphics and time-to-time auditory feedback relevant to the increased attention span as a positive reinforcement feature facilitated by these digital technologies. It was also observed that in order to redirect the students toward certain actions and to complete the task, verbal and physical prompts were often needed with consistent trials and practice. This accords with the previous findings that autistic students exhibit less anxiety or frustration when they have increased engagement (Neely et al., 2013). Teachers with more orientation for keeping the traditional elements involved reported more difficulty sustaining attention and motivation using only traditional activities throughout the learning session. So far, it has been established that digital technologies are used to mediate social techniques for autistic students with explicit training of skills such as joint attention (Fletcher-Watson, et al., 2016) to encourage student engagement in the classroom (King et al., 2014; Allen et al., 2016) and to influence their communication skills and social interactions through playful and collaborative contexts. However, the contrary view also exists, as perceived by some teachers, in that the ability to use technology for communication purposes may lead to isolation in autistic students if they are allowed to use it for a longer period without monitored guidance, as more collaborative use of technology is required for these students.

The findings also support the argument that repetition and practice retain and strengthen the learned skill as predictable responses, and the results achieved using an interactive app or program allow students to see the same reaction again and achieve the same results (Baron-Cohen, 2009). The strength of visual media is appealing and retains students' attention for a long time. The audio–visual features of a digital program present information through the screen in multiple ways, words, and images, which certainly suits the learning style of some autistic students (Allen et al., 2016). Nevertheless, some teachers raised the concern that prolonged exposure to screens may harm students' vision and produce other health concerns, hence, monitoring their use is recommended.

5.7. Digital technology promotes joint attention

The findings illustrated that on several occasions, autistic students were observed exhibiting social interaction, joint skills, and even motor skills when they were practicing

a game on a tablet. They were observed pointing on the game features or some request icons such as "I like this" and also looked at teachers to judge their reactions. The joint interactive learning session was considered a more advanced level and a milestone for NV autistic students. The findings affirmed that establishing a group-based task (peer-to-peer socialising) can motivate the child's communication effort. Peer mediation and adult instruction (from teachers/parents) through the right use of modelling and reinforcement direct them towards SC. In addition, pairing the child with peers in a mainstream setting enhances engagement and interaction and prompts expressive communication responses. Hence, when a peer-mediated approach is adopted when using the device, a more balanced response and initiation are obtained. This implies that the proximity created in a joint and collaborative learning/play space encourages the chances of joint attention and interaction. Interfaces with screens in a joint learning session allow students to sit closer together to engage (e.g., to look at the same screen or play the same application or game), hence facilitating the activities to promote joint attention and social orienting. This corroborates with the findings of Xin and Leonard (2014), who argue that the effective adoption of interactive technology devices as play objects is crucial in eliciting verbal and NV joint attention (van der Meer et al., 2017) and social engagement needed for verbal social skills in autistic students.

Understanding the development of joint engagement and attention is imperative for NV autistic students. Yuill (2021) relates his view to this point that these students may have specific difficulty in the generalisation of newly learned skills to a new context or even a different communication partner, and this is further aggravated when a social context or when communication partners do not support joint engagement positively. Some teachers from School 3 were of the view that technology contributes positively to joint attention provided that a variety of social activities and play are arranged. However, the observations showed that teachers incorporated a variety of strategies to engage autistic students in joint attention activities, but that there was little use of technological devices. The tablet was incorporated as a reward or sometimes as a motivator to guide and maintain students' attention, practice turn-taking, and enable them to learn the curriculum content.

It was observed that teachers used strategies in instructions to motivate the expressive communication of NV autistic students in classrooms. These included incidental teaching, repeating instructions verbally many times, and discrete trial training. However, the findings did not ensure the maintenance of the communication responses exhibited and their reflection in any other setting also generalisation was not the purpose of this study. Additionally, teachers' regular use of the digital device and prolonged engagement of the

student with the device could not direct their attention for long towards lessons only, and they may exhibit problematic behaviour in between. Another important aspect that was observed is that most of the teachers were just focusing on regular terms to increase communication, e.g., requesting phrases or words like "I want" and "I need". But, being in an inclusive setting, the peer collaboration enabled these students to learn other functions too that supported their spontaneous initiations and joint attention as well (in shared interface activities).

The facilitative role of technology was also evident in mediating practice for joint attention in activities where autistic students were engaged for a long time to match words with pictures, puzzles, and tracing games. The duration and time spent on practising these activities kept them engaged, and their prolonged engagement and eye gaze reflected a positive joint attention response. The findings presented by Tager-Flusberg et al. (2016) also determined similar views that prolonged engagement with activity on an interactive interface supports eye tracking, that is, the precursor for better receptive language in NV autistic students. Yet the findings of this study indicated that this only happened when they knew both pictures and the word and not for one they did not understand. This belief additionally indicates that practicing for joint attention facilitates further interaction and orientation in autistic children, as also exhibited by the findings that the emotions (happy gestures) and facial expression were also exchanged at various points between students who played a game collaboratively. Hence, digitally mediated joint attention can be used more as a facilitative means of enabling various other facets of joint attention through guided interaction by the teachers. The finding also aligns with Sterett et al. (2022), who identified the positive influence of using a speech-generating device in prompting language and communication responses in NV autistic children and their collaboration with a social partner.

According to social interactionist theories for language acquisition, developing joint attention in autistic students develops their social engagement and orientation during interactions designed according to the interests and communication level of the student (Edward et al., 2015). Knowing that the development of joint attention is crucial for early language development further supports adopting a social interactionist approach. The teachers reported that NV autistic students exhibited responses such as initiation of request, responsiveness to questions asked, and made social comments after the six-week training, compared with their prior practicing with PECS, which took more time to see obvious accomplishment of targeted skills. This relates to the perspective of Hampton et al. (2021) that the irregular patterns of maintaining the learned skills obligate the regular use of any tool involving digital technologies to retain the ability.

Additionally, digital technologies were used to deliver the lesson that underlies the facilitation of interaction and learning as it entailed collaborative activities, sometimes on the same screen that enabled turn-taking and motor skills and sometimes connecting the tablet to the projector for group learning. Gal et al. (2016) and Holt and Yuill (2017) mention the ease of engagement with technology for autistic students that improved their joint attention and engagement and accomplishing the initiation and responsiveness of joint attention when using the devices rather than in the session without the digital technologies. Therefore, this finding submits that the use of digital technologies possesses the tendency to promote joint attention in autistic students. However, the findings also indicate that these activities were not free of challenges encountered by teachers in executing technologically mediated sessions. For example, finding obtained through the responses and observation of School C was that with the use of digital tools, the learning effect may fade away when guidance is removed or it can be interpreted that the maintenance of learning was more limited to devices. Challenges include losing network connections, battery issues on the tablet, and the transition of students from one application to another application, and sometimes students being adamant about not sharing the device with other students. This has implications for the findings that show positive aspects and the role of technology in improving joint attention.

5.8. Role of digital technology and motor issues

The findings illustrate the concern of some teachers regarding the motor skills challenges of autistic students and the challenges they face in using digital technologies. So, it is reasonable to consider that proficient motor skills need to be supported that may help in establishing optimal opportunities to practice social skills (Kesari et al., 2013). The findings indicated that NV autistic students with motor difficulties faced issues in initial performance tasks on interactive mediums, and teachers had to make adaptations to motivate them to respond (e.g., the right positioning of the device increased the time to respond). Axford et al. (2018) referred to similar difficulties among NV autistic students when they have to practise using devices, e.g., devices or tools that require the precise placement of hands or fingers to avoid disorientation of the screen or moving on to an unwanted page. Sometimes, the control, pressure, and timing of finger movements cannot be determined effectively by these students. This indicates that enabling SC through digital technologies for students with fine motor challenges entail the factors of cognitive, perceptual, and motor dimensions as well. The findings indicate the need to have features built into the application design that facilitate motor skills as well. It was also observed that many features of games, like puzzles that foster tracing activity, enable them to practise motor

skills that require the accurate movement of fingers, a controlled grip on the device, and matching shapes on the screen. This aligns to prior studies where some applications facilitate motor skills with the opportunity for more repetition and practise, e.g., certain games that motivate the student to improve game scores in a collaborative session and that facilitates effective motor skill development (Cai et al., 2017). Furthermore, Desai et al. (2014) stressed the role of teachers as significant in this context, such as the need to increase their external guidance, instructions, and reinforcers for students with motor skills difficulties before the student extends learning past their ZPD and carries out the task independently.

5.9. Digital technology to promote social orienting

The findings illustrated that digital technologies were found to be a positive medium to facilitate the social orientation of autistic students. It was observed that traditional instructions without the mediation of technology did not accomplish their attention or eye contact towards the verbal instructions of teachers. Different activities incorporated into interactive interfaces discovered that due to engaged and interest-led learning on devices, NV autistic students exhibited a motivation to repeat the activities on the device. This gives a positive dimension to ponder, as prior studies explain that social orienting disparities in autistic students are exhibited as low motivation levels and interest in engaging in any social interaction (Chevallier et al., 2012; Kohls et al., 2012). The findings illustrate that the motivation students exhibited when the teacher introduced the device were related to their interest in a visual medium that retains and engages them towards learning and social interaction (Laurie et al., 2019; Clark and Adams, 2020).

These findings of developmental cascades of SC i.e., joint attention and social orienting using digital technologies substantiate with previous studies that has shown that technology is a facilitator of fostering collaboration, social orientation, and joint engagement (Bölte et al., 2010; Holt and Yuill, 2017). These findings are also supported by studies that have suggested that autistic children are more motivated to engage in social interaction when using digital technologies (Francis et al., 2019). The findings of this study explain that technology facilitates an environment for autistic students where they find it easier to engage in joint attention and engagement. Specifically, in 'joint performance', i.e., collaborative shared interface games or video-watching activities where enforced collaboration was attained between students by teachers, shared activity elicited various SC responses, such as imitation, initiation, and turn-taking. This corresponds to prior findings by Gal et al. (2016) and Holt and Yuill (2017), where the motivation to see what others are doing elicits social engagement in autistic students.

The findings suggest that to reinforce SC, NV students have to practise it through a series of interactions, such as the sounds they make, the words they produce, and the gestures they use. These are results from imitation and subsequent reinforcement, mainly through features of the application and some reinforcement such as verbal praise by teachers as well. This reinforcement, whether positive (sound of applause on the application when the child imitates the word right), negative ('oh no' sound when a failed attempt was made), or neutral ('try again' notification), directs the language responses in NV students. The positive cues reinforce the required utterances and add to their expressive responses in any form. It strengthens the chances that NV students will repeat those utterances intentionally. In other words, the feedback cues in the NV learning environment facilitate them to practice language.

Relative to this, a lack of engagement and eye contact with the teacher was observed while they were trying to engage them through verbal instructions, indicating that it could not be accomplished alone through explicit instructions. However, this does not undermine the role of the teacher in supporting SC – their guidance and support are needed for NV autistic students owing to their unexpected behaviours.

5.10. Teacher–student interactions, social constructivism, and language support with digital technology

Collaborative activity and learning were observed throughout, which reflected the role of teachers in cognitive development and interaction to use digital technologies effectively. The findings revealed that multiple techniques and methods are used by teachers to couple technological roles with their expertise to promote SC in non-verbal autistic students. The prominent attributes of teaching methods identified were child-directed incremental learning, scaffolding, intermittent interactions with consistent questioning, dialogues and feedback, discrete trial training, gradual guidance, transfer of learned skills, and rewards as reinforcement. This correlates with the view of scaffolding by Khaliliaqdam (2014), who elaborates that the construction of knowledge through dialogue endorses collaborative activity to embed knowledge, and the use of a potential artefact mediates learning and knowledge.

Different strategies were also used by teachers in collaboration with tablets as visual aids and reinforcers to avoid the disruptive behaviour occasionally exhibited by students. The findings explicated the role of the teacher as a more knowledgeable other (MKO), who scaffolds the use of technology from time to time and guides students in learning through the use of the digital tool. Brink and Ohei (2019) supports the idea that there should be

good communication relations between teachers and students to facilitate the required support. The importance of teacher–student interaction is also mandated by Badiah (2018), who cautions that unless autistic learners are exposed to encouraging and constructive interactions with teachers, they will not improve the required repertoire of social and communicative interactions.

From the social orientation perspective discussed above, the findings of this study present a positive dimension of how practice and regular repetition in a given context using digital technology (primarily tablets) could help direct their preferential *orientation* to the social cues; i.e., their engagement in different technology mediated activities that is further followed by taking turns and waiting for their turn enable them to do things together, and observing each other's actions helps them take *pleasure* in social interactions and *seek out* social exchanges (Stallworthy et al., 2023).

The findings illustrated that a rich social context, specifically in all three cases where a mainstream setting facilitated the interaction and communication of autistic students (both verbal and NV) with regular students, cultivated learning through a setting of collaborative learning and through systematic instructions and use of technology. This relates to the theoretical perception of social constructivist theory in which the development of language is a socially mediated phenomenon. Relative to regular students, knowledge and learning in autistic students should be provided systematically as knowledge, which, in other students, develops almost automatically (Flores and Ganz, 2007).

Given the context of this study's findings, i.e., using interactive intervention and technology along with instructional scaffolding, this is an appropriate mix to promote the precursors of SC skills, i.e., joint attention and social engagement that is advocated by previous studies. For example, the findings of the current study corroborate with the view of Fletcher-Watson and Happé (2019), stating that early language development and social interactions can be effectively facilitated, followed by retention in joint attention and orientation through the use of effective, interactive, and technologically mediated interventions in collaboration with instructional scaffolding. This further corresponds to the views of Hanley et al. (2014), who discuss the concept of social interactionist approaches that facilitate the social participation and interaction of autistic students in the presence of a teacher or parents. This setup of social interaction in the presence of a more knowledgeable other is significant for the interpretation of and timely responsiveness to the child's communicative attempt (Geib, 2018). This further relates to eliciting desired learning and behaviour through the teacher's or expert's responsive scaffolding (Haebig et al., 2013; Vygotsky, 1978). Fletcher-Watson et al. (2017) argue that effective collaboration between teacher, student, and interactive intervention can foster the

development of core skills in autistic students, including joint attention and pragmatic communication skills. Thus, through student-oriented strategies and instructional scaffolding, coordinated joint attention and orientation are said to establish communicative and reciprocal interactions (Bottema-Beutel et al., 2014).

The findings also substantiate the theoretical perspective directed by Vygotsky (1978), i.e., that development is closely linked to the learning tools incorporated into a task. The findings further reflect on Vygotsky's perspective on how the tools used in a daily social context shape thinking and the importance of social interaction in overall learning and development. According to Vygotsky, the development of language requires the coordination of different skills, i.e., cognitive, linguistic, and social abilities (Martíneza et al., 2011). Moreover, sociocultural interaction further assists this language development. In the process of communicative tasks, students first self-talk, which leads to the internalisation of their thoughts as inner speech that is transformed into direct speech and expressive communication later on. The identification of initial language development, which is self-talk, is exhibited through appropriate eye contact, ups and down in their voice tones, and different sounds (Stanley, 2011).

The findings of this study also indicate that the initial focus is placed on the most basic skills that subsequently lead to the development of more complex skills, such as constructing single-step handling skills (e.g., touching a specific icon on the display screen) with applications on tablets, and then moving on to a more complex level of the application to yield intra-verbal skills, i.e., making the request and answering questions by touching icons on the display screen. This links to the point made by Alatheeb (2017) that using technology-directed interactions could be aimed toward eliciting one or more verbal behaviours on different levels of a program. The initial levels on applications on tablets are designed to create cognitive skills by developing a single verbal skill and then advancing on to multiple verbal skills. This may also be linked to the perspective that the tablets serve as a reinforcer of skills that are already internalised in NV autistic students through some other social context, and it facilitates the demonstration of those skills and facilities for more learning and SC.

The findings of the current study are guided by social constructivist theory in that it explored teacher-led instruction and the co-construction of SC skills with autistic students using technologies within different kinds of social contexts, i.e., individual play activities and collaborative shared interface sessions in classrooms. The findings further indicate how NV students develop a cognitive understanding of the social context through interaction with others using technology as a mediator in a given learning context (Vygotsky, 1978). Enabling SC in NV autistic students further relates to their

understanding of the cognitive state of other people's minds that is thought to facilitate spontaneous reciprocal communication, and, if not, leads to indifference towards others (Fletcher-Watson and Happé, 2019). Relative to this, the interactions with parents and peers, facilitated by technology, as drivers of cognitive development have been mandated by previous studies, which also aligns with more specific theoretical perspectives of the ToM and other cognitive abilities in NV autistic students and their and social interaction (Rashedi, 2021).

The following section discusses the findings obtained under Research Question 3, which entails the factors that contribute to the use of digital technologies as a positive learning tool. Several factors have been identified that shape the teachers' perceived usefulness and ease of use of digital technologies. Numerous barriers and challenges identified by the findings were found to influence the positive role and contribution of these tools in supporting SC in NV autistic students.

RQ3. What are the factors contributing to the use of digital technology as a positive learning tool for NV autistic students?

Two major themes were identified under the third research question. First was the teachers' perspective on how the use of digital technologies affects time, effort, and experience aspects. Second, the teacher participants mentioned various challenges that inhibit them from availing the fullest potential of technology for NV autistic students.

5.11. Supporting SC with technology takes more time, effort, and experience

In addition to the evaluation of how teachers use digital technologies and how students use the digital technology for SC practice, the interview responses also determined the positive contribution digital technologies make in terms of time, effort, and experience for teachers in teaching NV autistic students. Different views of teachers were recorded, where most of the teachers were happy with integrating digital technologies into their teaching patterns as it saves them time, and improving technology-based content helps them overcome the challenges they have to counter in traditional curriculum design.

The next section of this discussion reflects on the varied views of teachers in this perspective.

5.11.1. Digital technologies take more time, effort, and experience

Most of the teachers associated the factors of time, effort, and experience in using digital technologies with NV autistic students. Teachers holding this view mentioned that the effort and time associated with the use of any technological application are mainly dependent on features compatible with the difficulties and learning needs of autistic students. Technology in teaching practices is certainly time-demanding and requires multiple resources.

A technologically mediated setup for autistic students requires detailed technical and technological procedures, resources, and support. Moreover, the abilities and developmental profile of each autistic student vary, and customising each application and program requires different technical settings and effort. It is also found that there is no standardised set of procedures for teaching autistic students and a predefined unified method of operating the use of digital devices. Instead, each teacher must determine the most appropriate way to use the tablets, and a pace is steadily built to succeed. To meet the varying communication and social needs of NV autistic students, the applications need to be highly customisable and offer the option of adjusting the features according to their respective students. Furthermore, they also mentioned technological features and programs are not easy to use with students who have complex learning needs. These students are unpredictable, and sometimes their behaviour makes it more difficult for the teacher to keep them well-behaved while using the technology. Moreover, the teachers felt they were impacted by the limited availability of programs and applications.

The findings also demonstrated the teachers' lack of skills to modify and adjust the features of the available application according to the learning needs of autistic students. This supports the findings of Maseri et al. (2021), who mention that ready-made applications with less flexibility in terms of modification cannot be an effective option for use in verbal communication practice with autistic students, and if teachers have to incorporate additional procedures to use this application, it takes more time and effort, and reduces the appeal.

Contrary to this, some teachers mentioned that setting up devices may be time-consuming, but delivering lessons using tablets is time efficient owing to students' familiarity with the device from use at home. The teachers reported that NV autistic students practiced initiation of request (of the objects they needed), responded to questions by pointing to the right object on the screen, and made more repeated social comments after practising it on a regular basis compared with their repetition with PECS that took more time to exhibit some response. This finding supports the views of Flores et al. (2012), who indicated that the use of the tablet offers an advantage in terms of the

amount of effort and load associated with implementation compared to pictures and card-based learning, which requires the preparation of picture cards, arranging them on tables for students, and movement from place to place. For this reason, devices are preferred over picture-based learning and communication. Flores et al. (2012) further mention that this preference for the tablet is associated with its ease of use, less preparation time for learning content, fewer resources required for application, and students' communication responses due to their interests and preference.

Relative to this, Hermawati et al. (2018) mention that devices are not always a favourable option or considered easy and effortless, as they may be overstimulating due to audio–visual effects, may create distraction, and offer too many options for students to choose from, and thus may pose challenges for teachers in terms of maintaining a structured learning environment. The time factor was also a challenge according to the teachers, i.e., the teachers who did not have enough knowledge of the tools had to spend a long time learning the right features relevant to the students' difficulties, and sometimes it can take a considerable amount of time to learn how to effectively use digital technologies in the classroom. Contrary to these findings, Lei and Morrow (2009) mentioned that time is only a major constraint when technology has to be implemented in the inclusive classroom.

5.11.2. Traditional techniques take more time and effort to engage students

Another perspective from the teachers was that digital devices save time and effort and enable a better learning experience for students. The digital scheduling of lessons is easy. The design and structuring of content and materials to support the multiple difficulties of non-verbal students are also easy. Teachers are of the view that multimethod traditional interventions are difficult and complex to design, time-consuming, and require more effort from the teacher compared to technological devices that help teachers to design focused instructional content to facilitate learning. Autistic students' learning cycle has been significantly promoted by digital devices, enhancing content organization and reducing physical effort, according to teachers. The learning cycle is promoted through use of digital technologies rather than traditional approaches that associates with the autistic students' affinity for digital interfaces, and they are more comfortable with the use of technology-based learning approaches (Zaki et al., 2017). Another view mentioned by the teachers is that device-based sessions, in comparison to the traditional PECS-based communication interventions, are more efficient. They mentioned the need for a lot of physical effort in exchanging pictures and moving to the communication book with picture strips, but now, handheld devices allow the student to make requests and comments with one tap. Along with all of the positive aspects, there are certain challenges and implications that teachers face while using and integrating these devices into their regular instructional regime. The

cognitive differences, sensory processing delays, and expression and motor skills challenges exhibited by autistic students at times can limit the actual benefit and convenience of the technology. In these cases, teachers must use the right mix of conventional intervention and technology to maintain the students' progress.

It took quite some time and effort for the teacher to maintain his response. As mentioned in the findings, students have to go through rounds of practice sessions to rehearse a skill using a device, and then teachers slowly remove their support to see whether the student can manage alone. Hence, some teachers believe that technology takes more effort and time, with some students posing more communication challenges. This supports the finding of Lorah et al. (2013), who discovered that teaching various communication behaviours, e.g., via tablet-based applications, was a potential contribution to improving, and maintaining the skill with several trials and practice, and in comparison, to other methods such as the traditional picture exchange technique, required less time.

The use of tablets relative to other digital technologies has been acknowledged by teachers who were more oriented towards using technology and allowing students to develop some independence. Similarly, O'Malley et al. (2014) mention that the tablet is an advantageous device for the ease it offers to both students and teachers through customisation and independence for students to complete the task based on their individual needs. This perspective is in line with the findings that teachers perceived the tablets as a more flexible medium for the delivery of their instructions rather than traditional approaches. They also endorsed the role of digital technologies in task completion; these tools also facilitate social cognitive skills and expressive communication skills through various application features. The majority of the teachers in the study expressed strong agreement regarding the ease of use of tablets in the classroom, but many exhibited concerns that were confirmed through observation. The teachers mentioned that the self-contained nature of these devices can develop a less demanding learning environment for autistic students. More specifically, the lower levels of social interaction loads associated with the interactive tools motivate them to direct their cognitive abilities towards learning. In terms of the issue of cognitive overload, the findings of the current study indicate that teachers overcame this issue through cooperative and group learning to avoid high cognitive load. This idea relates to the notion of cognitive load theory, in which working and learning in groups distributes the cognitive processing across students in groups (Moon et al., 2023). In addition, the teacher's guidance and scaffolding were retained from time to time to avoid cognitive overload when students practised some task or exercise on devices. In addition, to maintain a balance of their guidance and assistance, appropriate assistance

was embedded by teachers to avoid explicit help, for example, providing a hint when it was needed the most.

The following section is reflection on findings obtained under Research Question 4, which identifies the barriers and challenges in using digital technologies as a tool to support SC in NV autistic students. Several challenges have been identified that hinders the use of digital technologies effectively and impact the positive role and contribution of these tools in supporting SC in NV autistic students.

RQ4. What are the barriers and challenges to using digital devices as a tool to support SC in NV autistic students?

In this section, the findings that are relevant to Research Question 4 are discussed. As explained in previous sections, there were various positive contributions to overall teaching and learning procedures with the use of technology in all three schools, with variations to certain degrees owing to the provision of facilities and resources and the variation in attitudes towards these changes. Digital technology has been identified as an enabler and facilitative medium to practice SC in NV autistic students. However, these contributions do not come conveniently and smoothly; rather, various challenges and barriers were also identified for each of these schools. Some of the challenges were common, e.g., training and development provisions for teachers and lack of assistance staff in all three schools, whereas others vary, with challenges such as a lack of parental cooperation, performance follow-ups, and lack of technical facilities being more prevalent across S2 and S3.

5.12. Barriers and challenges in use of digital technology

The integration of digital technologies in the educational context is dependent on multiple aspects, including the teachers' motivational level. The most important challenges are the training facilities and programmes provided to the teachers specifically pertinent to the use of technology, the attitude of the teachers, their self-efficacy, and the support requirements. This is related to the aspect of motivation and passion for using technology that depends on whether it is easy to use and appropriate for the teaching process (Davis, 1989). Given this preview from prior studies, the findings of this study exhibited little evidence for the teachers' perspective regarding the consistent integration of technology to record the actual improvements in SC in NV autistic students. Though the perceived usefulness of technological tools is high, that does not guarantee the teacher's high level of motivation for the use of future technologies. Two major factors were identified here, i.e., a lack of support for teachers (inadequate training and development facilities,

competency, and knowledge level) and a lack of support facilities in multiple domains (access to devices for all students, technical support, and provisions). Teacher training is an important aspect that determines the efficient use of digital devices by autistic students. The advanced digital technologies are technical; therefore, without the adequate training of teachers and staff, these digital technologies cannot be effectively implemented for the better learning of autistic students. A well-trained, competent, and qualified teacher is required to effectively operate and guide students (who also have learning disabilities) to understand technology. The findings of the study in this context are also supported by the studies that show that the educational expertise and background of the teachers and their competencies to use digital technologies affect the technological execution and adoption (Lau and Sim, 2008) that is further initiated by the provision of training and support facilities.

5.12.1. Training and support provision

One of the major challenges identified under the idea of availing positive contributions from technology was the lack of teacher self-efficacy. It was observed that teachers were not proficient and competent in using technology the right way for NV autistic students. They knew to practise the available general applications for these students and were successfully engaging them with device-based practice; however, they did not have sufficient knowledge about the students' complexities and difficulties and how to use devices to develop functional communication outcomes. Nevertheless, they were able to direct them towards learning with the use of technology, but how long they would exhibit and retain their SC could not be estimated.

The findings also reflect the dimension of teachers' demographic characteristics that are assumed to have an impact on the effective use of technology for NV autistic students. Prior studies supporting this, such as Lau and Sim (2008), mention the relevance and significance of teachers' age, educational background, experience, and competency that influence their willingness to integrate digital technologies into the teaching process. Moreover, it is further consistent with former studies mentioning that the readiness of teachers to integrate digital technologies is shaped by their work experience (Ertmer, 2005). Besides this, the teachers' training was also found to have an imperative role in the effective integration of technology into their teaching methods. In contrast to these findings, prior studies, such as Alsalamah and Callinen (2020), mention that Saudi Arabia's Ministry of Education has already allocated SAR 2 million from the budget specifically to facilitate training programmes for teacher development. In light of this evidence, it is pertinent to mention the disparity of training provisions and funding allocation in educational institutes in more developed cities relative to those in less developed ones.

For example, the schools in Riyadh in this study had better facilities and overall accommodations relative to those in Qaseem. This disparity can be further interpreted to mean that, overall, the educational reforms in Saudi Arabia are distinguished as provisions for two disparate areas, and the inequity in the ways in which teacher education, technological provisions, and training being provided requires consideration from the authorities and an increase in the number and quality of graduates teaching in less developed cities.

Another important aspect observed in the findings was the inclusion of autistic students in the mainstream setting. The increasing trend of inclusion of autistic students with typically developing peers in regular classrooms to supports their social cohesion entails further dynamics of inclusion than just simple placement of the student in mainstream classrooms (Russell et al., 2022). However, the positive aspect identified in the context of the current study is that along with mainstream peers, these students were collaborating and adapting the right learning behaviour, but due to lack of assisting staff with teachers, individualised attention could not be delivered that is required for adequate focused instructions to NV autistic students (Al-Ahmadi, 2009).

Technology integration and adoption cannot be assumed easily without comprehending the motivational factors that maintain their adoption in the classroom and curriculum. With the successful integration of technology into the pedagogical process for autistic students' teaching and learning, the factors that will positively influence the teacher's motivation to continue with it are the provision of teacher training and development. The teachers' personal factors, including their interest in technological development and proclivity to learn more about technology, their years of usage, and experience with digital technologies, impact the acceptance and effective use of technology (Birkollu et al., 2017).

5.12.2. Lack of support provisions and resources

The findings also identified various support factors and provisions, i.e., technical assistance, lack of auxiliary staff in inclusive classrooms, and funding support for free access to more technological devices and applications in Arabic. Similar factors were identified in prior studies (e.g., Baglama et al., 2017). Clark and Luckin (2013) also stress that these elements – i.e., the technical facilities and structure, such as the continuation of services and network provision, and the educational use of the digital technologies – are correspondingly essential for efficient technology acceptance in schools. Moreover, in terms of executing technology-mediated lessons for autistic students, they require more sophisticated preparations. Donaldson (2015) mentions that autistic students require specialised services and preparations in educational settings owing to their diverse and varied social communication needs. So, if teachers are barred by these aforementioned

factors, they will not be competently prepared to support the difficulties faced by these students.

Structured guidance and appropriate assistance are only possible when teachers are trained by professionals to enable students with a myriad of interaction and communication challenges to enhance their abilities. The findings highlighted similar issues where teachers were limited to integrating the technology due to the perceived lack of control they may, and do, experience sometimes in a classroom where students use technology. Prior studies have presented this similar concern, e.g., Ozdamli and Hürsen (2017), who elaborated that teachers' concerns regarding the integration of technology in the classroom threaten their human role as a teacher in terms of guiding or directing students, and they anticipate students' overindulgence and orientation towards technology. In the same vein, the findings illustrate that teachers believe that when students use technology for learning, they can sometimes be more oriented towards the next step of doing the task or more interested in entertainment tools than learning on applications.

The findings pointed to the teachers' positive orientation towards technological use on the whole. However, some have concerns with pertinent challenges, such as the inefficient infrastructure or ineffective training systems that are mandatory to provide teachers of autistic students with essential knowledge about autistic challenges and interventions that work the right way for such students. Competencies and readiness are improved with periodic training. A well-trained teacher is up-to-date with the most effective ways of using technology and using their knowledge in the right domain to support the best social communication responses in children. Teacher training contributes to students' learning capacities in an inclusive setting. This mandates the role of authorities in facilitating technology-based training courses within their schools to address teachers' needs, skills, and knowledge on the use of digital technologies (Cramer et al., 2015). Earlier studies encourage the significance of collaboration between parents and teachers as it will enable and facilitate the productive use of technology in both school and home contexts. It will also pave the way for the generalisation of skills being learned in different settings (Cheung and Pomerantz, 2012). Some teachers in this study indicated the need for cooperation with parents to increase the pace of improvement in the SC in NV autistic students. To increase parents' participation in technologically mediated learning, school authorities should promote opportunities to overcome the limited collaboration between parents and teachers.

Lack of access to digital technologies was another challenge mentioned by teachers that limited them in terms of effectively managing SC difficulties of autistic students. The

findings highlighted teachers' concerns that they are limited due to the insufficient quantity of devices in classrooms. Authorities will not facilitate the provision of devices for the entire class, and they cannot afford it on their own for all students. Prior research has also mentioned this challenge as a barrier that is further proliferated by the high cost of devices, applications, and lack of funding from authorities. Otherwise, it is meaningless and will discourage the teachers from fully integrating the technology (Borg and Ostergren, 2015; Al-Moghyrah, 2017).

Summary

The findings, on the whole, present different notions that when digital technologies are used with NV autistic students to support SC, various factors must be considered. Teachers have to consider a range of variables in light of the varying degrees of difficulties and other co-existing challenges of each student; as Pecukonis et al. (2019) mentions, developing SC in NV autistic students requires the consideration of multiple factors. Therefore, keeping in view the coordination of all factors, acknowledging the significance of targeting these early SC variables, and devising the combination of strategies, teacher's support, and digital technologies will not only enable and support SC but will also improve SC in NV autistic students and direct the further development of different precursors of SC, including joint attention, imitation, initiation, and social orientation. The findings of this study as a whole also suggest that digital technologies are mediating , enabling, motivating and contributing tools as well as having the potential for promoting participation and engagement, since they enable interactive forms of communication (Parsons and Kovshoff, 2019). The teacher's intention to use both traditional methods and technology indicates their preference, or possibly, intention to keep their role active in practicing for SC through technology . However, it also calls for keeping certain things in mind before using digital technologies for NV autistic students, as illustrated by the findings. For example, applications/tools should be flexible enough to enable customisation; the motor skills needed to operate the program on the tablets facilitate students in this regard, and resources needed to execute a digital program and skills needed by teachers for using the specific program or digital application.

Another dimension of the findings is that it is difficult to estimate and generalise the findings to any other context because there are many factors that are important to consider with regard to the role of variables contributing to the promotion of SC in NV autistic students. However, it is noteworthy that digital technologies support students' ability to exhibit communication responses through their multi-functional attributes, but it

cannot be concluded that learning and preference advantage to support SC lies with digital technologies alone (Flores et al., 2012; Couper et al., 2014).

In addition, the findings among the major challenges of a of a lack of effective training provisions also relate to effectively dealing with autistic students in an inclusive mainstream setting. Teachers' efficacy and competence in using technology are significantly linked, not only to their age, years of teaching experience, level of education, and level of instruction, but chiefly to the provision of updated training to enhance their expertise and competence in dealing with and managing the complex needs of NV autistic students, which were weak in the majority of the participant teachers. In an inclusive setting, integrated sessions and expert and specialised teachers will be more helpful in enabling all students to progress together. Engaging with autistic students in a general inclusive classroom is quite a challenging task, and a well-trained teacher would know how to do that effectively. Knowing the significance of inclusion, the findings indicated that authorities need to recognise the importance of training and provide learning facilities for teachers to reinforce their knowledge on devices and yield better performance in autistic students' learning capacities along with their peers. The findings showed that teachers need to complete up-to-date training to enhance their competence, understanding of the varying characteristics of autistic students, and capacity to utilise both digital technologies and the right strategies that assist the NV autistic students with their SC challenges.

The following chapter provides the conclusion and recommendations, followed by implications for future research.

Chapter Six: Conclusion

6.0. Overview

This study assessed the use of digital technologies in supporting SC in NV autistic students in light of teachers' experiences and perspectives. The study generated evidence from teachers and direct classroom observations of NV autistic students, exhibiting the positive impact of digital technologies in supporting SC through interactive practice sessions and teachers' guided assistance. The study also identified multiple contextual factors, including that the preference towards technology is affected by various barriers and challenges, the teacher's role in guiding and scaffolding the NV autistic students, the inclusive classroom setting, and access to technological resources and features. Most notably, a lack of training facilities was identified as a potential challenge for teachers in terms of using digital technologies in the right way. However, the study does provide the opportunity to explore further variables other than SC in NV autistic students that could determine their academic development and positive behavioural potential.

The findings determined that teachers who employed more explicit instructions and feedback about their performance, along with the use of digital technologies with NV autistic students, reported better students' engagement and SC. The findings also highlight the importance and power of the positive reinforcement methods adopted by teachers to direct students to repeat the learning task and to keep their behaviour appropriate. The digital technologies were found to contribute towards keeping these students on their learning tasks, and enabled maximum repetition and practice, leading to communication attempts, joint attention, and social engagement, provided that one-to-one structure is maintained in a mainstream setting.

The findings obtained under this domain are a contribution to the dearth of evidence in the Saudi context that relates to supporting SC, specifically NV autistic students. Social communication difficulties are prominent challenges that characterise autistic behaviour other than restricted and repetitive behaviours and narrow interests (APA, 2013). These students have problems with SC in both functional (like asking for or pointing to the object they need) and pragmatic ways (like starting any task that makes it harder for them to interact socially and cooperatively with their peers), which makes it challenging for them to have good interactions with their peers. Hence, these elements restrict them in their social domain, limit their communication repertoire, and also develop challenging

behaviour in these children. This compels the need for advanced technologically mediated solutions to support these students in developing academically.

One of the important dimensions identified in this study comprises two connected fields of interest, i.e., teachers' instructions and digital technology. This dimension illustrates the importance of verbal instructions in cognitive development, which links to the social skills perspectives of Vygotsky (1962, 1978). The findings from multiple qualitative cross-case study suggest that a common trend prevailed in all three schools, such as technology-mediated instructions to help support SC, with variation in preference towards practicing with these NV students using more instructions than technology. This showed the comparison of the use of mixed approaches in an inclusive setting where teachers prefer the use of both, but with more preference for instructional methods and using digital technologies to facilitate learning. Moreover, the mixed approach was found to effectively engage and motivate autistic students more than the use of traditional materials alone used to enable SC. Given the underrepresentation and underreporting of NV autistic students and their SC development in prior studies, this study identified that NV autistic students can be motivated and directed to learn through the interactive use of digital technologies as an interface alongside other strategies and instructional approaches by teachers. Therefore, the results of this study have opened up the pathway for further exploration on how to effectively incorporate the use of digital technologies along with the effective role of teachers, because their guidance is essential.

Owing to the increasing integration of technology globally and, pertinently the role of Saudi educational authorities in integrating and adopting technological solutions effectively in the educational domain in both general and special education, this study has provided an insight into the status quo of technology use and execution for NV autistic students. The study focused on multiple dimensions of interest that have evolved during the pursuit of assessing the use of digital technologies with NV autistic students. First, the inclusion of these students in the mainstream setting has illustrated the need to improve the configuration of an educational facility that addresses the learning needs of these students in a mainstream, inclusive context. Second, the use of digital tools to specifically manage SC challenges was more of a reinforcer, facilitator, and supplement to the overall learning. The facilities and resources to address the SC challenges of these students were not up to the par, and access was not enough for teachers to cater to the individual needs of each student. NV autistic students are more complex in terms of needing teachers' attention, interaction, and guidance, and the lack of additional teachers impedes the ability of teachers to attend to these students on a one-to-one basis, an issue also cited by prior studies. On the whole, the current study is a novel narrative in the Saudi context in terms

of exploring NV autistic students' learning and determining policies that can effectively incorporate educational approaches and digital technologies.

6.1. Recommendations and implications for authorities and stakeholders

Given the current research findings, it is imperative for key stakeholders to further develop the existing knowledge and insights derived from the perspectives of teachers in supporting SC through the utilisation of digital technologies. Following potential implications are worth mentioning and considering:

- *Recommendation 1:*

The findings have multiple implications that can potentially contribute to the existing literature in numerous ways. Initially, it became evident that the majority of teachers exhibited a favourable disposition towards the integration of technology in their teaching practices. However, their inclination was towards a blended strategy, wherein technology was utilised as a supplementary tool to support instructional methods and primarily employed to reinforce the practice of SC . The adoption of a mixed approach is not inherently unacceptable; however, it is recommended that educators and authorities enhance the various facets that can contribute to the continued improvement of these implementations. Research-based interventions and practices that include digital accommodations and the provision that allow the exchange of natural language interactions, as well as traditional teaching methods, effective cues, and reinforcement strategies, are needed to help non-verbal autistic students learn verbal language better.

- *Recommendation 2:*

This study highlights the crucial influence of contextual variables on the SC of autistic children. It emphasises the importance of providing technological provisions and accommodations in inclusive settings that cater to the individual needs of these students. Additionally, it recognises the significance of teachers' training and development in comprehending the actual challenges faced in SC. Furthermore, it emphasises the importance of fostering interaction between teachers and parents to gain a better understanding of the challenges experienced at home and school. This understanding can then be used to train them effectively using digital technology in both contexts. In light of the findings, i.e., where teachers faced challenges due to inappropriate classroom structures, resources, and facilitations, it is recommended that the authorities facilitate resource rooms with multiple commercial technological tools and sufficient infrastructure to better aid the SC of NV autistic students. There should also be investment in and

allocation of funding towards subscriptions to more expensive applications that are currently unaffordable for teachers and parents, making expensive technology more accessible. Saudi educational authorities should consider corrective and development measures to address this issue to overcome sensory, social, physical, and organisation challenges in inclusive settings, as autistic students are quite sensitive to all of these domains.

- *Recommendation 3:*

It is imperative for future research, authorities, and policymakers to prioritise increased collaboration among service providers and key stakeholders such as teachers and parents. This collaboration aims to foster a productive platform for comprehending various aspects and specificities of social communication-related behaviours. Additionally, it seeks to establish guidelines for the appropriate utilisation of digital technologies in supporting non-verbal autistic children. Therefore, the findings of the current study indicate that authorities should prioritise the implementation of standardised assessment procedures to enhance the identification of challenges faced by NV autistic students in a more professional manner, as well as directing the assessment procedures to estimate the transfer and utilisation of SC in a natural and non-technological context. Moreover, the aim and intent of future research should also be to assess the generalisation of skill development programmes using digital technologies.

- *Recommendation 4:*

Additionally, it is recommended that the categorisation of non-verbal autistic students be mandated, as this will facilitate the selection of appropriate diagnosis and intervention strategies. The need to have specific applications that address the nonverbal challenges of NV autistic children should be expedited. The educational authorities and school supervision staff should collaborate with developers and software engineers to help develop prototype applications that are accessible, multimodal, and customisable for the varied needs of NV autistic students. It is imperative for the authorities to prioritise the enhancement of teacher–parent collaboration in order to effectively identify and enhance social cognitive skills within the home environment. Parents play a crucial role as significant contributors, and their involvement cannot be disregarded. Improving collaboration between teachers and parents would contribute to the identification of more effective digital technologies and techniques, as well as the development of implementation frameworks and service provision in various social contexts.

- *Recommendation 5:*

It is recommended that educators prioritise the cultivation of the learning function of digital technologies over maintaining the facilitative function of these tools. The findings indicated the tendency of most of the teachers to self-learn relevant technical skills and expertise to address the varied profiles of students with SC difficulties.

It is imperative to incorporate into the curriculum or educational policy the endorsement of successful training that involves the actual utilisation of digital technologies via suitable applications, with a specific focus on improving social cognitive difficulties. Being in the developing phase of technological integration, the authorities in KSA have not fully realised the significance of training and development provisions for teachers, support facilities, and access to devices for each student in the classroom. These challenges further contribute to the ineffective use of technologies to address the SC challenges of NV autistic students. Hence, they prevent teachers from responding to the needs of autistic students proficiently.

- *Recommendation 6:*

One of the key findings of the current study is the ability of technology to inspire the engagement, attention, and motivation of autistic children and its ability to direct students towards certain tasks. This is one of the fundamental arguments for developing and providing more technological provisions and recommendations from authorities. Therefore, the research implies that even though the available technologies and simple applications hold the potential to help NV autistic children interact and communicate to some extent, it is likely that the initial appeal of these available tools may fade away over a period of time due to the novelty effect. Thus, novel and more up-to-date technological solutions that work on a more intricate level to not only manage SC challenges but also improve the SC of NV autistic students should be prioritised, as the current trend in the domain of educational technology is to accommodate more modern solutions such as educational robots as assistive tools for autistic students. Therefore, authorities need to develop programmes and seminars, considering success stories from other parts of the world, that integrate these modern ideas and technologies. In this way, NV autistic children can be helped to enhance their relationships, interactions, and communication with their typically developing peers.

- *Recommendation 7:*

In addition, despite authorities' efforts to provide technology and motivate its integration into the classroom, the study findings suggest that to increase the effectiveness and role of these digital technologies, there is a need to address and correct the SC challenges

faced by administration and authorities that interfere with teachers' effectiveness. The practice of differentiated instructions should be fostered in an inclusive setting that takes into consideration the unique challenges and difficulties that are encountered during the learning process. Hence, this suggests that digital technologies that can facilitate differentiated instructions with less effort and time for teachers should be implemented as soon as possible. The facilitation and provisions specified in terms of additional staff in class, resource provisions, and classroom configuration should be addressed on a priority basis.

The study also suggests that teachers customise instructions as per the learning needs of the individual student. However, most importantly, the 1:1 teacher-student interaction is the most important, as identified by prior studies (Shoener et al., 2008). The findings also suggest that deeper insight into the challenges of NV SC difficulties, sensory processing, and other elements delaying students' SC could be determined through a one-to-one approach; for example, Koegel et al. (2019) mention the significance that one to one teacher-student interaction holds for NV and minimally verbal autistic students, as this group seeks the greatest support, and addressing their needs with a differentiated interactive approach can be achieved when teachers can spend time with them individually. Accomplishing 1:1 teacher-student efficacy is related to other student arrangements, e.g., a small group structure or one-to-one instruction, teacher-oriented instruction, active collaborative participation, appropriate and positive teacher feedback, and progress monitoring of student performance.

- *Recommendation 8:*

The participant teachers, despite preferring integrating technology in teaching, were inefficient in using technology to help NV-autistic children develop their SC. Through their efforts and use of digital technologies, they facilitated combined attention and social involvement through interactive and group activities. This implies that despite past studies on lack of training, the problem is not being addressed. Training and development programmes should help introduce effective interventions for NV autistic pupils and enable instructors to utilise them. Other challenges include a lack of proficiency and knowledge among the teachers and limited training opportunities and technical facilities. Thus, it is recommended that teacher training programmes incorporate three key elements: improving theoretical knowledge about the challenges of NV autistic children; practical teaching skills and technical skills that will enable them to use technology effectively with students who demonstrate challenging behaviour; and the development of more positive beliefs and attitudes towards the role of technology in improving different skills in these students.

6.2. Implications for practitioners

The study findings specified the need for specialised instruction interventions to not only support SC, but also to develop SC to the point that it aid further literacy and academic performance in autistic students. Future studies also need to consider the use and execution of computer-assisted interventions, which have been used so far for non-verbal autistic children in the Saudi context. The study results identified a gap in access to evidence-based practices, interventions, and more versatile technological tools. It is understood that having access to these varied practices and technological interventions followed by teachers' willingness and commitment to execute them diligently will show positive and quantitative outcomes in these students. In the Saudi context, the lack of training facilities and other support resources contribute to the lack of knowledge and awareness in these teachers about using technological tools the right way and executing interventions specific to NV autistic students, so the findings of the study identifies implication for practitioners towards improving the awareness of authorities and administrative bodies in order to take the required corrective actions in the necessary domains. Some of the potential implications in light of current study findings are detailed below:

- *Implications for practice 1*:

The practitioners need to consider the element of cultural sensitivity when developing support systems for communication and socialisation among NV autistic students. The findings indicate that within a social context, there are various contextual factors that may influence the learning of autistic students. For instance, cultural elements are one of the important factors that need to be endorsed. Likewise, the selection and execution of digital technologies should adhere to the cultural context when it comes to their selection and modification for use, as if this element is ignored, there may be limitations to achieve improvement in the targeted areas of concern

- *Implications for practice 2*:

The data collected for the current study is enlightening as it considers a neglected end of the spectrum, i.e., NV autistic students, and in the Saudi Arabian context, too. The findings have implications for practice and policymakers to consider the missing aspects in terms of provisions in the main cities of Saudi Arabia for support as well as improvements in the challenges facing autistic students. The results could help professionals figure out how to encourage the further development and useful use of

digital technologies that are specifically made to help NV autistic students with their SC problems.

- *Implications for practice 3*:

It is recommended that practitioners focus on the execution and practice of more naturalistic teaching strategies in a controlled learning environment to improve the coping skills for an unexpected event such as a change of teacher, change of classroom location, off-classroom context in the playground and during breaks, varying the learning material, technology, and other content, individualised instructions using technology and materials of high quality, and introducing some creativity in learning like relaxation exercises.

- *Implications for practice 4*:

The findings also demonstrate that SC skills are complex, and therefore addressing them requires versatility. Practitioners should promote provisions and strategies that consider the complexity of the communication needs that are being addressed or could be addressed through the use of a wide variety of differentiated instructions and digital technologies in different contextual settings. For this, there is a need for more technological affordances, features, and applications to be provided by the authorities so that NV autistic students can avail multiple interfaces and programs, that may be used keeping in view their particular difficulties with SC.

- *Implications for practice 5*:

The current findings of this study found a positive aspect of students' affinity towards digital technologies and availing of this opportunity to facilitate their concentration and focus on improving their SC difficulties, although this is constrained by challenges of the right setup and provisions in an inclusive setting. Therefore, this underpins the recommendation for practitioners to execute efficient evaluation systems, not only for the progress of NV autistic students but also for the progress and performance of the teachers. This further highlights the need for practitioners to prioritise the adoption of comprehensive strategies to transform knowledge into action by providing adequate systems, services, and support for the use of digital technologies for NV autistic students. According to recent studies, the prevalence of autistic individuals and the challenges faced by students are still escalating (Al-Dakroury et al., 2022). This indicates some level of failure on the part of authorities in terms of tracking the improvements and practices being used as per the prescribed guidelines in educational policies. To ensure that there are no gaps between policies and actual practice, ongoing monitoring and evaluation should follow these executions. Therefore, practitioners and policymakers need to use educational

technology for evaluation purposes that would not only help them save time but would also enable better monitoring of procedures and obtaining access to feedback from teachers and other stakeholders. A digital evaluation tool needs to be integrated into the educational context to measure the progress of both students and teachers, considering parents' feedback in this evaluation, which must be followed up to keep the system transparent.

6.3 Proposed development areas in future research

Development in future research is required that recommends the assessment of more potential benefits and contributions of digital technologies for NV autistic students. Many prior studies have emphasised the contribution of different augmented and alternative communication devices to enable SC skills, in NV autistic students, but using basic technological tools (McNaughten and Light, 2013). So, this is indicative that modern tools and applications, if utilised effectively, will not only manage but also improve these SC difficulties. Specifically, tablet computers are found to be promising in supporting social pragmatic skills and expressive and receptive language, as they are more influential in engaging the sensory, cognitive, and perceptual skills of autistic students. Future research developments should take into consideration how to develop opportunities to enable access to these applications in Saudi schools to overcome resource inadequacy and help teachers tackle the SC skills among NV students more effectively. The research on approaches and interventions should be considered, which pays attention to the visual cognitive challenges and difficulties of these students, and then the applications or features that offer customisation should be used to avoid cognitive and visual loads and ease and support the communication process. The role of multimodal approaches was found effective in prior research as well, but could not be explored in the current study due to inadequate technological facilities in the case study schools. Future research should evaluate these approaches and calculate the effect of new, innovative approaches that capitalise not only on SC skills but also on other dimensions such as motor skills, sensitivities, and behavioural challenges.

With the recognition of the increased scope of technological integration and also the social challenges and communication needs of autistic students in the Saudi context, future research and development should consider how to ensure digital technology-based communication methods for these students. Before that, it is also important to determine the current communication abilities and difficulties of these students. In addition, research and development should further accommodate the role and significance of parental

cooperation, awareness, and training to help address the SC difficulties with their equal contribution. The generalisation of skills requires practice and learning of the same tasks in a different context, so future research should develop in this context by taking parental perspectives into account and determining their attitude towards the use of digital technologies for SC skills improvement. Support outside the classroom context, e.g., in the home, is important for extended practice and repetition. Parental inclusion and partnering are important. Parents should also be trained in the skills to enable them to reinforce their child's learning at home, monitor what they are doing on devices, and be able to connect with and modify their child's learning at home as well. Hence, many research areas need to be explored in the Saudi context regarding NV autistic students and addressing their complex communication and social needs.

6.4 Limitations

The research was conducted across three different schools in KSA: two in Riyadh and one in Qassim. It cannot be assumed that the findings of this study could be extended and generalised to other school settings in other cities in the KSA. However, the specific research that was carried out across these three schools facilitated the extension of an existing knowledge base about the use of technology for NV autistic students and determining gaps that limit the effective use of digital technologies for these students. Besides this, the findings do offer guidelines that can be used by teachers and policymakers to assess how the technology is being used with NV autistic students and how better facilitation and training can further improve the gap that remains to actually develop and enhance SC in NV autistic students. The study sample size was not large, but it was adequate enough to consider teachers' opinions and views on the use of technology that contributed to understanding their perceptions and make comparisons to the expected level of technology use for autistic students by the authorities and the Educational Ministry.

However, opinions from other important and relevant stakeholders (e.g., parents, researchers, special education teachers) could have been more influential and produced more diverse views. A related limitation was the limited time taken to conduct the research, i.e., in a given span, the data was collected that produced specific information from the given limited sample. During the research process, every phase was conducted smoothly, including the sampling and participant recruitment, even though data collection was interrupted during the global pandemic and some of the participants were interviewed online. Hence, due to this limitation, the details and observation sessions were affected as they impacted the planned sessions for ongoing observation.

Baron-Cohen (2006) proposes that autistic learners are systemisers, and they learn effectively in a well-organised setting and with effective guidelines. However, our findings illustrated that in an inclusive setting and confronting many challenges, the classroom configuration and use of technology were not systematic, but random. Qian and Lipkin (2011) mention that, being atypical learners, autistic students can easily store specific examples, but generalisation to other contexts is difficult. Therefore, the study only obtained information about how the support of digital technology is assisting practice and achieving students interest , attention and engagement that further enabled their multiple SC responses in a given context, and was unable to determine the transfer of these responses to different settings.

Another limitation worth mentioning is the lack of inclusion of the voice of autistic students, owing to these participants being NV. However, past research and current trends in the global autism community show that it is very important for the success of research and for researchers to include the voices of autistic participants in the process of building knowledge (Parsons et al., 2021). Future researchers require an epistemological understanding that guides their research approach, with the aim of influencing practice and developing a new knowledge base with the inclusion of autistic individuals that acknowledges, reflects, and respects their perspectives.

Another important aspect to consider in future research that might have influenced the findings of the current research to some extent is the reactivity and demand characteristic during observations and data collection through interviews. Zahle (2023) explains that during the data collection process in a particular setting or situation, the ongoing research may influence the participants due to the presence of the researcher, and this may lead them to disclose responses that align with the researcher's interests. Although the underlying research followed the more current stance of reactivity, this suggests that it is acceptable to use data gathered from reactive situations, provided that the researcher is aware of the phenomenon and can account for it when drawing conclusions (Zahle, 2023). However, critics consider good data to be reactivity-free, so future researchers should ensure the cultivation of a situation that does not facilitate reactivity. On the other hand, demand characteristics are the subtle indicators that participants may perceive during a study that could potentially reveal the true purpose or aim of the research and may affect their responses or behaviour to match the researcher's interests (McCambridge et al., 2012). The current research took the necessary steps to ensure this effect was minimised by keeping questions open-ended to obtain full and unbiased responses using multiple data sources (observation sheets, interview recordings, reflective journals) to maintain transparency and cross-check for biases and member checking. Future researchers should

further assess elements to overcome the limitation of any possible biases and demand effects by developing more trust and rapport with the respondents, making them feel comfortable about their responses, improving reflective practice, and using non-leading questions that would also alleviate the pressure on the participant to give particular responses (Secules et al., 2021). Researchers should also thoughtfully probe for more data through follow-up questions (Berger, 2015).

The distinctive point of this research was that it targeted NV autistic students in order to regulate their SC difficulties using digital technologies.

6.5 Concluding remarks

The overall results of this study manifest on the notion that digital technologies can serve as a facilitating tool, enabler, and contributor to manage SC difficulties in NV autistic students. The role of digital technologies, according to the teachers' experiences and opinions, and their use with students, is exhibited more as a supplementary and facilitative one in collaboration with traditional teaching techniques for NV autistic students. However, the barriers and challenges to the use of digital technologies are substantial school C, with the less-developed Qassim city experiencing more of these challenges.

In addition, the findings indicate that one size does not fit all, and that technology alone is not a holistic solution; rather, there are multiple factors that impact its successful execution, including SC-specific applications, teachers' skills and expertise, their guidance throughout, and the compatible learning layout of the given setting to reinforce the learning of these students in an inclusive setting using digital technologies. The fact that technological use and integration cannot be ignored links to the preference of students for technology. Therefore, this directs the teachers to adopt a student-centred approach, but the role of instruction is equally important in light of social development theory, as are interactions for these students. Moreover, group-based tasks were found to be effective, particularly when working on different domains of SC, including interaction, social orientation, joint attention, and ToM.

In terms of autistic students' proclivity towards technology to communicate and socially interact, it has been identified that collaborative sessions and peer-mediated practices are more suitable options to support the SC of these students. However, for success, better classroom layouts, facilities, and provisions may be needed to avoid other behavioural manifestations occurring in autistic children. In addition, for this approach to work, peers should be well- trained to develop a positive attitude towards autistic students; this is significantly important, as peers are key collaborators in facilitating interaction in the classroom. The main point of emphasis is that Saudi Arabia needs to be more open to

mainstream inclusive learning. Peer-mediated intervention and training could help meet the different needs of NV autistic students if good practices are put in place and good support is given. The case studies indicated that teachers did support inclusive settings, but they faced challenges due to inadequate preparations for NV autistic students. Another important implication of endorsing peer-mediated learning is effective planning and systematic intervention, as autistic students, specifically NV students, are susceptible to social isolation (Koegel et al., 2012).

The findings of the underlying study contribute to the existing literature in the Saudi Arabian context to understand the relation between different precursors of SC skills, i.e., joint attention, social orienting, and social interaction, to progress to subsequent language outcomes through technologically mediated assistance. The findings have effective implications for teachers, practitioners, and other relevant authorities working to facilitate digitally mediated solutions for autistic students. Considering the variations in the SC profile of NV autistic students, it is recommended that the existing gaps are addressed using the right tools, applications, and programmes, along with the facilitation of teachers' development specific to the use of technology with NV autistic students.

For better integration of technology, Saudi authorities need to recognise several necessary arrangements that were absent from all three schools. Among the various challenges identified, the most important was the arrangement and organisation of autistic students in a mainstream school. To keep the quality of education for these students effective in a mainstream setting, the authorities and school administration should make necessary amendments to the classroom structure and accommodations, the time available for teachers to teach autistic students and general students, and the total number of students in the classroom. In addition, modifications to technology-based provisions and general upgrades are necessary. In addition to these developments, more advanced technological interventions that are culturally appropriate are required, such as SC-specific Arabic versions of applications, especially for NV autistic students, that are directed towards developing social communication skills. For further support, these accommodations should be facilitated by the teacher's professional development, content-specific training, and knowledge provision on research-based interventions and practices to enable them to recognise the student's level of SC difficulties and weaknesses in order to establish the right learning style and deliver appropriate guidance.

This major finding calls for more rigorous research that accommodates a larger sample size and measures other aspects related to NV autistic students that may assess the improvement in their SC. One of the major indications obtained from all three cases is that peer teaching and training in the mainstream inclusive setting should be fostered to help

teachers overcome the obstacle of a lack of assistant staff. Paparella and Freeman (2015) mention that significant improvements can be made in joint attention, imitation, social orientation, interaction, and ToM (understanding other voice tones and facial expressions), as well as pointing to needed objects in training sessions with peers. Likewise, one of the important findings of the underlying study is that peer collaboration is an effective opportunity to support SC incorporating digital technologies. Hence, planning a peer collaboration session would direct their observation and stimulate interaction and joint attention with their regular classroom peers. These are the potential opportunities in an inclusive mainstream setting, but should be mediated by interactions and monitoring by teachers from time to time.

On the whole, it can be concluded that despite the integration of technology and advanced solutions, the Saudi authorities and ministries cannot facilitate the successful and effective use of technology to improve SC difficulties. The disparities in the provision of technological resources and accommodation in different schools in different cities, which may be due to an inequitable flow of funds and allocation of trained staff in both developed and less developed cities in Saudi Arabia, need consideration. Shane et al. (2012) indicate that a reliance on the provision of technology and stressing its use will not bring about developmental changes in autistic students or improve their complex communication needs. Instead, actual engagement and motivation to learn and exhibit SC responses are shown when regular monitoring of provisions, effective training of teachers, collaborative interventions, implementation support, and the customisation of learning methods and modules are carried out. It has been established that teachers primarily work on practicing SC, i.e., requesting preferred items, labelling pictures, and pointing to desired things. However, for better gains, improving SC requires utilising more advanced and individualised functions of digital technologies, advanced training, and resource provisions. The identification of substantial challenges and barriers indicates the void between the robust initiatives being undertaken under the domain of Vision 2030 for teacher training and development and for special education students, and calls for practical solutions to barriers like lack of training provisions, i.e., the motivation level of teachers to receive training, lack of trainers, and lack of relevant training programmes and training centre facilities.

Greater efforts are needed to effectively implement technological interventions by examining and understanding teachers' experiences and attitudes towards digital resources. The current study has not fully assessed the potential of digital technologies. More research is needed to assess the actual potential of technology that can contribute to the improvement of SC and ultimately skills in NV autistic students. This should include

the escalation of research and development to facilitate easy access to training and provision to ensure successful gains for NV autistic students with complex communication needs. Hence, future studies should capitalise on broadening the function and use of technology for improvements.

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Appendices

Appendix 1A: Research Ethical Approval

University of Nottingham
UK | CHINA | MALAYSIA

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19/12/2019

Our Ref: 2019/53

Dear Mohammed Alassaf

Thank you for revising and resubmitting your research ethics application for your project:

An Exploration of Social Communication Skills in Nonverbal Autistic Students using Digital Applications (Tablets) in Saudi Arabia

Our Ethics Committee has looked at your re-submission and has the following comments.

- We see this as a 'high risk' project, not as you state 'low risk', and ask you to be aware that researching with vulnerable young people with autism will always be seen as having a high risk in particular with respect to their ability to grant informed consent. We understand children are highly unlikely to be able to give informed consent. Your detailed account of the revisions has enabled a prompt response from the ethics committee.

Before your research can be approved, the Committee requests the following amendments are made:

- There is still no timeline for data generation. **The duration of the field work extends from 25th December 2019 to 25th February 2020.**
- In the list of questions and PIS documentation, the term 'autistic children' is used. It is preferable to speak of 'children with autism'. We suggest that this term be used throughout. **Thank you for the detailed explanation about why you chose to ignore this point and continue to refer to children as 'nonverbal autistic children' throughout rather than as children with 'nonverbal autism'. As you say this is contested and the discussion will feature in your thesis.**
- Given that observations will be made in classrooms, there should be greater attention to ethics: students, parents and school leaders will need to grant access, permission and give consent. The letters, information sheets and consent forms need to be developed in the first instance. **These have been provided.**
    - **The PIS (leaders) states the data will be 'treated with anonymity'. You know who you are observing so the data are not anonymous. However, you will anonymise the data as soon as possible. Clarify this for participants.**
    - **Make sure the contact details for the Education Research Ethics Committee to the PIS. It is given on the consent form but you will take that away.**
    - **Give participants the opportunity to consent to each aspect of the project individually. It will show they have read the consent form carefully.**
- Information is clear and the form content is fine for teachers (some formatting would make them tidier including taking out reference to 'an important person'). **Removed.**
- Consent form: You only want confirmation so there is no value of a 'no' column. **Altered.**
- PGR students need to know that the data they are collect is primarily the responsibility of their supervisors. These should be shared and left with the supervisors. **Provision made for access.**

+44 (0)115 9514470
educationadmin@nottingham.ac.uk
nottingham.ac.uk/education

- The duration of the data retention begins from publication of data not its generation. **Amended.**

Based on the above assessment, it is deemed your research is:

- **Approved subject to agreement to amend the documents as above (an email confirming that will suffice).**

Confirmation received that these changes will be made 19/12/2019
Research approved 19/12/2019

We look forward to hearing from you with the information that is requested.



Dr Kay Fuller
Ethics Chair

Appendix 1B(a): Parents Consent Form

The University of Nottingham

Consent Form for Parents of the Children to Do Classroom Observation

Title: An Exploration of Social Communication Skills in Nonverbal Autistic Students using Digital Applications (Tablets) in Saudi Arabia.

Please read the statements below and sign the form, if you want to participate in the study:	**Yes**
I acknowledge that I have read the information sheet and understood the study and its detail. I have had the chance to raise queries related to the study and have my questions answered.	
I understand that I am free to withdraw my child from the research at any stage, participation is entirely voluntary and there are no consequences if she/he withdraws.	
will ensure I understand that the researcher will ask for the consent of all participants including (my child) the presence of a guardian where necessary.	
I understand that my child's personal information will not be included in any parts of the research findings and my child's personal information will remain confidential.	
I understand that the documents collected will include observational notes, teaching plans, teaching materials that teachers will share with the researcher.	
I understand that the researcher will be observing my child and making field notes.	
I understand that all recorded data will be stored in a password protected UoN OneDrive file and only the researcher and two supervisors will be able to access the data. All data will be stored for a period of no less than 7 years from publication in line with the regulations of the UoN data protection and GDPR policies.	
I understand that I may contact the researcher or supervisor if I require further information about the research and that I may contact the Research Ethics Coordinator of the School of Education, University of Nottingham if I wish to make a complaint relating to my involvement in the research.	

I agree to my child being observed as part of the research:

Observation ☐**YES** ☐**NO**

Name of Child: _____

Name of Parent: _____

Signature: _____

Date: _____

Researcher's full name : Mohammed Alassaf mohammed.alassaf@nottingham.ac.uk	Researcher (signed): .....
Supervisor's full name: Dr Debra Costley http://www.nottingham.ac.uk/education Dr Anne Emerson anne.emerson@nottingham.ac.uk	University of Nottingham School of Education Dearing Building, Jubilee Campus Wollaton Road Nottingham, NG8 1BB UK

- **For any further information please do not hesitate to contact the researcher or the supervisor at the contact details provided above or contact with School of Education Research Ethics Coordinator:**
  educationresearchethics@nottingham.ac.uk

Appendix 1B(b): Parents Information Sheet

Information sheet for participants (Parents)

Research Title: An Exploration of Social Communication Skills in Nonverbal Autistic Students using Digital Applications (Tablets) in Saudi Arabia.

Researcher's details:

My name is Mohammed Alassaf, a PhD student at the University of Nottingham, the United Kingdom (UK). I am conducting a study titled "An Exploration of Social Communication Skills in Nonverbal Autistic Students using Digital Applications (Tablets) in Saudi Arabia". It is supervised by Dr. Debra Costley and Dr. Anne Emerson, both from the University of Nottingham. The study has received ethical approval from the University of Nottingham, School of Education.

Invitation to participate in the research:

Your child's school has been chosen because the opinions and experiences of teachers in the school are relevant to the teaching of non-verbal autistic students to contribute to this study. Your child's participation is on a voluntary basis. Your child has the right to withdraw from this study at any time without having to give an explanation. Kindly read and understand the aim of conducting this study and what your child's participation will involve. I plan to be in the school from ( ) to ( ) during which time I will observe the students (which includes your child) and interview the teachers. If anything is unclear or if you would like more information, please contact me at mohammed.alassaf@nottingham.ac.uk

Aim of this research project

This part of the study aims to gain an understanding of how digital applications (tablets) are used to address social communication challenges faced by nonverbal autistic children in Saudi Arabia. Specifically, the study will explore how teachers use digital applications (tablets) to support the development of students' social communication skills, and ways in which non-verbal autistic students use digital applications (tablets) for social communication. In addition, it will also examine the factors contributing to the use of digital applications (tablets) as a positive learning tool for non-verbal autistic students. I would also like to observe teachers and students (which include your child) to see how far students and teachers interact with these devices.

students. I would also like to observe teachers and students (which include your child) to see how far students and teachers interact with these devices.

Participant requirements:

In this study, teachers will be requested to contribute their experiences and views about how they have used digital technologies to support social communication challenges faced by nonverbal autistic children in your child's school. The observation will be carried out at a time and place convenient to your child and their teacher. I will seek your consent for note-taking during observations in order to simplify the process of transcriptions. You will also be asked to provide consent for me to observe your child during teaching and in meetings/gatherings which I might attend.

Participants' rights:

You have the right to accept this invitation or not. You can also decide at any point in time during the study to withdraw your child from participating. You also have the right to ask any question arising from the observation guide. The right to withdraw your child at any time from the research will in no way adversely affect your relationship with the school or the researcher.

What happens to the data?

All data from the research project will be treated with confidentiality and your child, the school and teachers will be provided with a pseudonym to preserve anonymity. In situations where the results of this study are published in international journals and discussed in conferences, you and your child will remain anonymous. In the resulting thesis and any publications, pseudonyms will be used. The research data will be encrypted and stored in a password protected computer and the University of Nottingham (UoN) OneDrive, which only the researcher has access to. In case my supervisors need access to the data, I will provide them with the OneDrive access. In line with the University's regulations, Anonymized data will be kept 7 years from publication. After this period, they will be permanently deleted.

You can contact me at any time for further information and if you are not satisfied with your involvement in the study you can contact my supervisors or the School of Education Research Ethics Committee. All of their details are provided below.

Thank you very much for your help. We really appreciate it.

<table>
<tr><td colspan="2">Researcher's full name:

Mohammed Alassaf
mohammed.alassaf@nottingham.ac.uk</td></tr>
<tr><td>Supervisor's full name :

Dr. Debra Costley
http://www.nottingham.ac.uk/education

Dr. Anne Emerson
Anne.Emerson@nottingham.ac.uk</td><td>Associate Professor Education
School of Education
Dearing Building
Jubilee Campus
University Of Nottingham</td></tr>
</table>

- **If you have any concerns about your involvement in this research you can contact the School of Education Research Ethics Committee: educationresearchethics@nottingham.ac.uk**

Appendix 1B(c): Teacher Consent Form

Consent Form for *Teachers*

Title: An Exploration of Social Communication Skills in Nonverbal Autistic Students using Digital Applications (Tablets) in Saudi Arabia.

Please read the statements below and sign the form, if you want to participate in the study	**Yes**
I have read the Participant Information Sheet and the nature and purpose of the research project has been explained to me. I understand and agree to take part.	
I understand the purpose of the research project and my involvement in it.	
I understand that I may withdraw from the research project at any stage and that this will not affect my status now or in the future.	
I understand that while information gained during the study may be published, I will not be identified and my personal results will remain confidential.	
I understand that I will be audio recorded during the interview, and I will be observed in the classroom and taking note.	
I understand that data (audio records, field note and transcriptions) will be stored in a password protected UoN OneDrive file and only the researcher and two supervisors will be able to access the data. All data will be stored for a period of no less than 7 years from publication in line with the regulations of the UoN data protection and GDPR policies.	
I understand that I may contact the researcher or supervisor if I require further information about the research, and that I may contact the Research Ethics Coordinator of the School of Education, University of Nottingham, if I wish to make a complaint relating to my involvement in the research.	

- **I agree that I will be observed as part of the research: ☐Yes ☐No**
- **I agree that I will be interviewed as part of the research ☐Yes ☐No**

Name of teacher: _____

Name of School: _____

Signature: _____

Date: _____

Researcher's full name : Mohammed Alassaf mohammed.alassaf@nottingham.ac.uk	Researcher (signed): ……
Supervisor's full name: Dr Debra Costley http://www.nottingham.ac.uk/education Dr Anne Emerson anne.emerson@nottingham.ac.uk	University of Nottingham School of Education Dearing Building, Jubilee Campus Wollaton Road Nottingham, NG8 1BB UK

For any further information please do not hesitate to contact the researcher or the supervisor at the contact details provided above or contact with School of Education Research Ethics Coordinator: educationresearchethics@nottingham.ac.uk

Appendix 1B(d): Teacher Information Sheet

Information sheet for participants (teachers)

Research Title: An Exploration of Social Communication Skills in Nonverbal Autistic Students using Digital Applications (Tablets) in Saudi Arabia.

Researcher's details:

My name is Mohammed Alassaf, a PhD student at the University of Nottingham, the United Kingdom (UK). I am conducting a study titled "An Exploration of Social Communication Skills in Nonverbal Autistic Students using Digital Applications (Tablets) in Saudi Arabia". It is supervised by Dr. Debra Costley and Dr. Anne Emerson, both from the University of Nottingham. The study has received ethical approval from the University of Nottingham, School of Education.

Invitation to participate in the research:

You are being invited to take part in this research study because your opinions and experiences are relevant to the teaching of non-verbal autistic students to contribute to this study. Your participation is on a voluntary basis. You have the right to withdraw from this study at any time without having to give any explanation. Before you decide whether to take part in this study, kindly read and understand the aim of conducting this study and what your participation will involve. If anything is unclear or if you would like more information, please contact me at mohammed.alassaf@nottingham.ac.uk

Aim of this research project

This part of the study aims to gain an understanding of how digital applications (tablets) are used to address social communication challenges faced by nonverbal autistic children in Saudi Arabia. Specifically, the study will explore how teachers use digital applications (tablets) to support the development of students' social communication skills, and ways in which non-verbal autistic students use digital applications (tablets) for social communication. In addition, it will also examine the factors contributing to the use of digital applications (tablets) as a positive learning tool for non-verbal autistic students. I would also like to observe teachers and students to see how far students and teachers interact with these devices.

Participant requirements:

In this study 3 or 4 teachers will be requested to contribute their experiences and views about how they have used digital applications (tablets) to address social communication challenges faced by nonverbal autistic children in your school. The interviews will be carried out at a time and place at their convenience. The interview is expected to last for up to 45 minutes, depending on how much they need to consider their statements and to respond. I will seek their consent for note-taking and audio recordings during interviews in order to simplify the process of transcriptions. The teachers will also be asked to provide consent to be observed during teaching and in meetings/gatherings which I might attend.

Participants' rights:

The participants have the right to accept or decline this invitation. They can also decide at any point of time during the study to withdraw from participating. They have the right to refuse to respond to any question if they wish so. They also have the right to ask any question arising from the interview and observation guide. The right to withdraw at any time from the research will in no way adversely affect their relationship with the school or the researcher.

What happens to the data?

All data from the research project will be anonymised. The school, teachers and students will be provided with a pseudonym. In situations where the results of this study are published in international journals and discussed in conferences, teachers will remain anonymous. In the resulting thesis and any publications, pseudonyms will be used. The research data will be encrypted and stored in a password protected computer and the University of Nottingham (UoN) OneDrive, which only the researcher has access to. In case my supervisors need access to the data, I will provide them with the OneDrive access. In line with the University's regulations, anonymized data will be kept for 7 years from publication. After this period, they will be permanently deleted.

You can contact me at any time for further information and if you are not satisfied with your involvement in the study you can contact my supervisors or the School of Education Research Ethics Committee. All of their details are provided below.

Thank you very much for your help. We really appreciate it.

<table>
<tr><td colspan="2">Researcher's full name:

Mohammed Alassaf
mohammed.alassaf@nottingham.ac.uk</td></tr>
<tr><td>Supervisor's full name :

Dr. Debra Costley
http://www.nottingham.ac.uk/education

Dr. Anne Emerson
Anne.Emerson@nottingham.ac.uk</td><td>Associate Professor Education
School of Education
Dearing Building
Jubilee Campus
University Of Nottingham</td></tr>
<tr><td></td><td></td></tr>
</table>

- **If you have any concerns about your involvement in this research you can contact the School of Education Research Ethics Committee: educationresearchethics@nottingham.ac.uk**

Appendix 1C(a): School Leader Consent Form

Consent Form for School Leaders

Title: An Exploration of Social Communication Skills in Nonverbal Autistic Students using Digital Applications (Tablets) in Saudi Arabia.

Please read the statements below and sign the form, if you want to participate in the study:	**Yes**
I have read the Participant Information Sheet and the nature and purpose of the research project has been explained to me. I have had the chance to raise queries related to the study and have my questions answered.	
I understand that (teachers) will be interviewed and (students, teachers) will be observed in the classroom.	
I understand the purpose of the research project.	
I understand that I may withdraw from the research project at any stage and that this will not affect my status now or in the future.	
I understand that while information gained during the study may be published, we will not be identified and our personal results will remain confidential.	
I understand that all recorded data will be stored in a password protected UoN OneDrive file and only the researcher and two supervisors will be able to access the data. All data will be stored for a period of no less than 7 years from publication in line with the regulations of the UoN data protection and GDPR policies.	
I understand that I may contact the researcher or supervisor if I require further information about the research and that I may contact the Research Ethics Coordinator of the School of Education, University of Nottingham if I wish to make a complaint relating to my involvement in the research.	

I agree that (teachers) will be interviewed and (students, teachers) will be observed in the classroom. ☐**YES** ☐**NO**

Sharing documents ☐**YES** ☐**NO**

Name of Leader: _____

Name of School: _____

Signature: _____

Date: _____

Researcher's full name : Mohammed Alassaf mohammed.alassaf@nottingham.ac.uk	Researcher (signed): ……
Supervisor's full name: Dr Debra Costley http://www.nottingham.ac.uk/education Dr Anne Emerson anne.emerson@nottingham.ac.uk	University of Nottingham School of Education Dearing Building, Jubilee Campus Wollaton Road Nottingham, NG8 1BB UK

- **For any further information please do not hesitate to contact the researcher or the supervisor at the contact details provided above or contact with School of Education Research Ethics Coordinator: educationresearchethics@nottingham.ac.uk**

Appendix 1C(b): School Leader Information Sheet

Information sheet for (Leaders)

Research Title: An Exploration of Social Communication Skills in Nonverbal Autistic Students using Digital Applications (Tablets) in Saudi Arabia.

Researcher's details:

My name is Mohammed Alassaf, a PhD student at the University of Nottingham, the United Kingdom (UK). I am conducting a study titled "An Exploration of Social Communication Skills in Nonverbal Autistic Students using Digital Applications (Tablets) in Saudi Arabia". It is supervised by Dr. Debra Costley and Dr. Anne Emerson, both from the University of Nottingham. The study has received ethical approval from the University of Nottingham, School of Education.

Invitation to participate in the research:

Your school has been chosen because the opinions and experiences of teachers in the school are relevant to the teaching of non-verbal autistic students to contribute to this study. The teachers' participation is on a voluntary basis. They have the right to withdraw from this study at any time without having to give any explanation. Kindly read and understand the aim of conducting this study and what their participation will involve. I plan to be in schools from ( ) to ( ), at a time to be negotiated with you. If anything is unclear or if you would like more information, please contact me at mohammed.alassaf@nottingham.ac.uk

Aim of this research project

This part of the study aims to gain an understanding of how digital applications (tablets) are used to address social communication challenges faced by nonverbal autistic children in Saudi Arabia. Specifically, the study will explore how teachers use digital applications (tablets) to support the development of students' social communication skills, and ways in which non-verbal autistic students use digital applications (tablets) for social communication. In addition, it will also examine the factors contributing to the use of digital applications (tablets) as a positive learning tool for non-verbal autistic students. I would also like to interview only teachers and observe both (teachers and students) in the classroom to see how far students and teachers interact with these devices.

Participant requirements:

In this study 3 or 4 teachers will be requested to contribute their experiences and views about how they have used digital applications (tablets) to address social communication challenges faced by nonverbal autistic children in your school. The interviews will be carried out at a time and place at their convenience. The interview is expected to last for up to 45 minutes, depending on how much they need to consider their statements and to respond. I will seek their consent for note-taking and audio recordings during interviews in order to simplify the process of transcriptions. The teachers will also be asked to provide consent to be observed during teaching and in meetings/gatherings which I might attend.

Participants' rights:

The participants have the right to accept or decline this invitation. They can also decide at any point of time during the study to withdraw from participating. They have the right to refuse to respond to any question if they wish so. They also have the right to ask any question arising from the interview and observation guide. The right to withdraw at any time from the research will in no way adversely affect their relationship with the school or the researcher.

What happens to the data?

All data from the research project will be anonymised. The school, teachers and students will be provided with a pseudonym. In situations where the results of this study are published in international journals and discussed in conferences, teachers will remain anonymous. In the resulting thesis and any publications, pseudonyms will be used. The research data will be encrypted and stored in a password protected computer and the University of Nottingham (UoN) OneDrive, which only the researcher has access to. In case my supervisors need access to the data, I will provide them with the OneDrive access. In line with the University's regulations, anonymized data will be kept for 7 years from publication. After this period, they will be permanently deleted.

You can contact me at any time for further information and if you are not satisfied with your involvement in the study you can contact my supervisors or the School of Education Research Ethics Committee. All of their details are provided below.

Thank you very much for your help. We really appreciate it.

Researcher's full name: Mohammed Alassaf mohammed.alassaf@nottingham.ac.uk	
Supervisor's full name : Dr. Debra Costley http://www.nottingham.ac.uk/education Dr. Anne Emerson Anne.Emerson@nottingham.ac.uk	Associate Professor Education School of Education Dearing Building Jubilee Campus University Of Nottingham

- **If you have any concerns about your involvement in this research you can contact the School of Education Research Ethics Committee: educationresearchethics@nottingham.ac.uk**

I agree that teachers will be interviewed and students and teachers will be observed in the classroom. ☐**YES** ☐**NO**

Sharing documents ☐**YES** ☐**NO**

Name of Leader: _____

Name of School: _____

Signature: _____

Date: _____

Researcher's full name: Mohammed Alassaf mohammed.alassaf@nottingham.ac.uk	Researcher (signed), ...

Appendix 1D(a): Observation Sheet

STUDENT OBSERVATION FORM

LEARNER'S SPECIFICATIONS: **AGE:**

CLASSROOM LAYOUT/AMBIANCE **TYPE OF LESSON:**

CHECKLIST:

Total devices in classroom:

Availability of digital device to each participant:

ACTIVITY	COMMENTS	REFLECTIVE NOTES
Explicit interaction activities between teacher and NV student		
Program being used among students with the digital technology		
Appear indifferent to other people		
Prefer to study and play alone		
Accept contact if initiated by others		
Initiates contact/contacts with other or showing attention		

Appendix 1D(b): Teacher's Observation Schedule

TEACHER'S NAME: _____ **QUALIFICATION:** _____

SUBJECT: _____ **TIME:** _____

PROFESSIONAL KNOWLEDGE:	**COMMENTS/ SPECIFIC EXAMPLES**
• Knows the use of digital application effectively • Knows how to use it for autistic students • Demonstrate accurate knowledge and expertise of subject matters and device being used • Demonstrate skills while practicing the digital application	
INSTRUCTIONAL DELIVERY	**COMMENTS/ SPECIFIC EXAMPLE**
• Understands each student's learning differences • Delivers the instructions according to difficulty level of the student • Communicates clearly • Gives adequate attention and time to make student understand • Attends to students' problems they face in using application • Execute instructions gradually • Assesses progress of students after the session	
ADDITIONAL NOTES:	

Appendix 2: Categories of Applications used on Tablets

The application were used to practice SC relevant tasks such as speech recognition, learning and recognising object names of different categories, i.e., animals, fruits, numbers and alphabets.

Learn Arabic Flash Cards for kids Picture & Audio





The application was used to play as a collaborative game by matching the puzzle pieces of different categories of objects.





Appendix 3: Interview Questions

INTRODUCTORY PROTOCOL

Dear Sir,

My name is Mohammad Alassaf, as a part of this interview and with your due consent, I would like to audiotape our conversations of interview today. Moreover, for your further information, only researchers of this study would have access to the audiotapes and recordings.

Introduction

This research project focuses on the use of digital technologies for NV autistic students to support their SC difficulties. You have been recognised to speak with me today on this perspective as a potential participant for the research as you will be having a great insight to share with us. The intent is to learn more about how technology can help address or incorporated in teaching strategies for these students rather than evaluation of your use with them. Hopefully, this interaction would be a great learning experience for us.

Interviewee background:

Gender: _____

Age: _____

Teaching experience: _____

Educational background/specialisation _____

Teaching experience with special students

1. How long have you been practicing the teaching profession?
2. How long have you been teaching autistic students?
3. How long have you been practicing the teaching profession?
4. What educational curriculum do you use in the classroom?
5. What kind of tech tools are you using in the classroom at the moment?
6. What do you think of the advantages of digital technology in the classroom for NV autistic students over the use of traditional teaching strategies?
7. Do you think that digital technology contribute to the comprehensive improvement of the learning and teaching process of NV autistic students? If so, what are the methods?
8. Do you think digital technology contribute to the social interaction skills of autistic students? If so, what are the methods?
9. Do you think that using digital technology to improve social communication skills of NV autistic students might take more time, effort and experience?
10. How much support is currently provided by school authorities in implementing digital technology (tablets) to improve social communication skills in NV autistic students?
11. What is your view regarding the effectiveness of training teachers to use tablets efficiently with autistic students?
12. How would you rate the current level of support provided to autistic students for using digital technology?
13. What do you consider to be the main barriers for teachers in their use of digital technology in the classroom to improve social communication skills for NV autistic students?

Appendix 4: Theme Development Matrix

Theme development matrix Data sources used (Interview guide, Observation field notes, personal journaling)				
Research questions	**Codes**	**Descriptions of codes**	**Themes**	**Description of themes**
How do teachers use digital technologies to support SC in NV autistic students	Types of learning methods and techniques for NV autistic students	**Examination of all types of techniques and methods using digital technology for developing SC skills for NV autistic students**	Combination of technology and traditional methods for NV autistic students	Autistic students have varying and complex learning profiles depending upon variations in their difficulty level of social communication complexities. Learning alone with digital technology cannot be a solution in every situation so the combination of both digital and traditional technique can help address SC skills for appropriately
In what ways do NV autistic students use digital technology for SC?	Developing social interaction techniques and activities using technology for NV autistic students	Assessing the possible ways of cultivating social interactive activities in a way that are favourable for	Contribution of digital devices to social interaction in NV autistic students	Interactive play and shared interface contribute to social interaction Social interaction activities using technology and digital technologies promotes joint attention and social orientation that are precursors of SC skills

		learning of autistic students		
	Determining other improvements if any with use of digital technologies	Assessing if technology-based support is only limited to promoting social interaction skills or any other changes are also observed	Promotion in the student's learning and multiple skills using digital technologies	Autistic children may also show changes in other areas with technology-based lessons i.e. academic skills and also support in overall learning and teaching processes
What are the factors contributing to the use of digital technology as a positive learning tool for NV autistic students	Determining all contributing and challenging factors in terms of time, cost, structure and experiences in use of digital technologies and applications with NV autistic students			
		Assessing the contribution in overall learning and teaching domains	Contribution of digital devices to learning and teaching processes	The promotion of SC may be influenced by a set of factors that may be contributing or intimidating in terms of time, efforts and experience executed by teachers. These may further include challenges and limitations that further limits teacher's expertise to utilise digital skills in right way to address SC difficulties in NV autistic students.
		Assessing multiple factors that may impact the execution of digital technologies with NV autistic students having SC difficulties	Time, effort and experience as intervening factors in SC skills development	

			Challenges to using technological devices for autistic students	
What are the barriers and challenges to using digital technologies as a tool to support SC in NV autistic students?	Determining all the challenges and limitations in use of digital technologies for NV autistic students	Challenges and barriers such as specifically provision of resources, training facilities, lack of staff and technical assistance	Challenges and barriers to effective use of digital technology to support SC in NV autistic students	Multiple factors hinder the potential execution and adoption of digital technology that particularly includes teachers in competencies due to lack of required training and development. Provisions